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GLANCES

AT THE

GEOLOGICAL SURVEY.

BY CHARLES WHITTLESEY.

[To the Editor of the Ohio State Journal:]

There were circumstances connected with the organization of this survey that led necessarily, to a want of efficiency. The chief geologist was allowed to charge all his time to the State, and to spend a large part of it in New York city, making the business of the State a secondary matter, and the amount of field-labor, dependent upon his own convenience.

On the part of the Legislature and of the State authorities, it does not appear that any one has examined into the mode in which this work has been accomplished.

I am free to confess that, considering the absence of home control and of responsiblity, the results have exceeded my anticipations. In these results, so far as they add valuable information of the mineral region, I think we should give the assistants most of the credit, who are required, at a smaller salary, to devote all their time to the service.

The Legislature of 1872 undertook to remedy some of the defects arising from absenteeism, by establishing a *Geological Board*, to exercise a supervision over the *Geological corps*, which had thus far been wholly irresponsible. One of its excrescences was lopped off, but up to this time no power in the State has been able to keep the chief geologist at home, to control his selection of agents, or to bring the headquarters or the specimens to Columbus.

What I now propose to ventilate is the consequences to the mineral region of the *Northeastern district* in a practical point of view; a part of the State over which the chief geologist has assumed to have, and has been allowed, full control. Four years of the survey have passed, and we have had three reports. Of thirteen counties in that district, including onehalf the minerals of the State, not one has been reported upon in detail. The counties of Summit and Trumbull, which only corner in the coal field, are the only ones fully reported upon,and in these reports there is little which was not known and published before the survey was ordered. If the field work of the coal region has been done, why is it withheld from the public? Coal and iron ore are the principal minerals of the State,and if the survey has been thoroughly made, developing anything new with regard to them, are not the people of that district entitled to it at the earliest moment?

Those counties outside of the mineral region, in the Northeastern district, purport to be completed, and are reported

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upon. We have prolonged disquisitions upon general geology, especially of the strata outside of Ohio—such as might have been written at any time without field labor. Why are the material interests of Ohio, which were the prime objects of the survey, postponed or neglected?

I ask the attention of the authorities to this feature of the reports, so far as Professor Newberry has had control of them. But I go farther, and call their attention to a much more important feature of his work, and to state that as a surveyor in reference to *mines and minerals* he is neither reliable personally to do the work, or to supervise and control it.

This is a broad charge, and with the limited space I can command, it is difficult to present my view of it in a satisfactory manner, but I shall make the attempt.

If I am right he has misconceived the geological structure of the northeastern counties, by relying upon methods of exploration that are not exact; that is, by ignoring *physical geology*. In the limited and vague reports he has condescended to make, neither the number, the order, the dip or the extent of the coal beds, are correctly set forth. Errors in the description of a fossil or of strata, which do not produce minerals, are not fundamental. They are merely mistakes in science. Those which mislead the public as to the number and the value of mineral beds, are vital.

He has adopted a theory of undulations in the strata, that after more than thirty years, applying the spirit-level to obtain the elevation of hundreds of mines and mineral beds, I am unable to discover. The close detailed observations of the southeastern district have not disclosed them. When the work of the two districts comes to close up on the line of the Ohio Central railroad, which will be received as most correct? Will the Geological Board not require the different branches of the survey to harmonize, and at least present a common result? Will they allow the chief geologist, whose talents lie in quite another field, with a troop of the eleves of Columbia College at his heels, to sweep leisurely over the country, and override the opinions and the observations of resident assistants?

I admit our coal field to be irregular and difficult of exploration, which establishes the necessity of something more than mere impressions and opinions, and of something more exact than a traveling barometer, subject to a plus or minus error of ten feet. There are mineral beds, which are a less distance apart than the constant errors of the barometer.

The determination by fossil remains, and by the associated rocks, is still more uncertain. Nothing short of actual levels, geometrical and mathematical work, such as Prof. Mather required in the old survey, will give results which will stand the test of time. It is precisely such dull and trifling details which Prof. Newberry ignores. But the facts of nature and physical geology are obdurate. The most lofty and self-confident genius cannot alter them.

General conclusions and reports make short and easy work. They save field labor, make a brilliant show on paper and render criticism of details difficult; but they do not fulfill the duties of an explorer, or build up a lasting reputation.

To prove that I am not like him, dealing in glittering generalities, I shall give the result of a part of the triangulations I have made in the lower coal series of the Northeastern district, which I hope those interested will not consider too dull reading to be passed over.

If there are *four general undulations* of the coal-bearing strata, like long waves, *one* in the valley of the Kilbuck, *another* in the valley of the Tuscarawas, a *third* between Big Sandy and Yellow creek, and a *fourth* on Yellow creek, there must be in these strata four instances of a *reverse dip*. Not one of these have I discovered, except those local undulations that are seen in all mines. The lower seam of coal, or "No. 1," lies on a very uneven floor, in a series of local troughs, or basins, but these basins descend in regular order toward the central portions of the main coal field. It is not uncommon to find twenty, and sometimes fifty feet change of level in the same mine, on the strength of which the chief geologist once reported a coal seam that did not exist, and brought down another, two strata below its place. The general decline of the beds toward their common center is very irregular, as to the rate per mile, and is often very small. They are sometimes flat and locally reversed, but these are rare exceptions, not affecting the general rule.

There is an instance of the fatal result of hasty generalizations, in the survey of Southwestern Kentucky, where the true number of the coal beds is nearly doubled. In Ohio the beds are *not continuous* over large fields, in any direction, either along the line of strata, or down the line of dip. The accompanying beds of iron ore and limestone have the same characteristics. If this is true the few sections which have been published, to illustrate the Northeastern district, seriously misrepresent the system. In fact, they cannot be made consistent with themselves. If correct profiles or physical sections shall be given hereafter, they will show a wide difference in the *number* of coal beds at different places; a mathematical proof, beyond cavil or argument, that the beds are not continuous. This disappearance and reappearance is exactly what our geologists were employed to determine. It is their duty to descend to details, and to show how far these beds may be relied upon for workable value, especially beneath the surface. Superficial opinions are worse than nothing; for they mislead those who are most deeply interested. In the triangles I have made by the aid of the level, the chain and compass, and by county maps, the sides or the length of the lines between mines and outcrops, is seldom less than *two* miles, generally more than *ten*, and often more than *twenty* miles. Long lines eliminate the effect of local distortion.

On the National road coal seam "No. 1" appears in the tops of the hills at and around Brownsville, seven to ten miles west of Zanesville, 400 feet above Lake Erie, dips to the east and is seen no more. In the valley of the Licking it lies about 475 feet above Lake Erie. At Zanesville, thirteen miles southeast, it has plunged so far beneath the river, that a limestone bed 80 feet above it, comes down to water level only 111 feet above the lake.

At the head of Simmons creek, six miles west of Coshocton, coal seam "No. 6" of the reports, is about 503 feet A. L. E., and at Coshocton, according to the report, only 248, a descent easterly of at least 250 feet.

It does not follow that seam "No. 1" on the Walhonding, is the same bed as *No.* 1, on the National road, but the bottom seam now open is 348 feet A. L. E., and therefore all the seams up to No. 6 of the reports, have sunk their united thickness and 100 feet more in the direction of Coshocton, down the channel of the Walhonding to Roscoe.

Following the repert, "Sanders's mine," near Millersburg, is No. 6, and is 534 feet above Lake Erie, so that at Coshocton, about 20 miles nearly south, it has sunk at least 280 feet. I make the mean elevation of the mines at Uhrichsville 340 instead of 275 feet as given in the report, and those at Trenton, three miles west, about the same, the different openings having a difference of 10 to 20 feet.

The old entries around the mouth of Old Town creek and New Castle, which are no doubt in the same bed as those of Trenton, Uhrichsville and New Philadelphia, and are from 350 to 360 feet A Lake Erie, and those near New Philadelphia 400 to 410 feet. These are nearly level, but incline to the southeast 60 feet in 8 miles. From Sanders's (if both belong to No. 6) to New Philadelphia is 29½ miles, S. 74° east, and the descent is about 130 feet. It is precisely here, on the theory of the report, there should be a *reverse dip* to the west or northwest, which is to take place beneath the highlands, between Kilbuck and Tuscarawas.

Proceeding up the valley of the Stillwater south of Uhrichsville, No. 6 disappears below the channel, and also No. 7, which is about 100 feet above it. Near the sources of the Stillwater the great Pittsburg seam crops out, from under the highlands of Belmont and Harrison counties.

To conform to the theory of the report, both these seams should rise to the east and southeast, and then plunge in the same direction, beneath the Pittsburg and Wheeling seam, which everywhere in those counties dips *southeasterly*. On the west side of the Tuscarawas it must also dip to the northwest. For neither of these conclusions do we have anything but opinion.

Passing northerly and easterly into the valley of Big Sandy, in the report of 1870, we have three printed sections around Zoar and the Newberry mine, where it may be supposed the chief geololist, should have some personal knowledge.

At Cameron's old bank, three miles north of Millersburg, the bottom seam is three hundred and sixty feet, and at the mouth of Newman's creek, two miles north of Massillon, three hundred and forty-six, so near on a level, as to demonstrate that the line of bearing is nearly on a line between the two, or north fifty-four deg. east; and if there is any such thing as dip in this bed, it is in a direction about southeast. In that direction it disappears beneath water level, and at Zoar station a lime rock, which at Massilon is 160 feet at least above coal No. 1, has sunk below canal level, which is 313 above Lake Erie. Either coal No. 1 has sunk 150 to 200 feet in a southeastern direction, in a distance of fourteen miles, or it has been entirely lost. If there is an undulation between the Kilbuck and the Tuscarawas, its axis is nearly north and south, and it is therefore oblique to the well determined bearing of the strata, which is an absurdity in geology. At Zoar station, by Prof. Newberry's section, No. 6 is 462 feet A. L. E. which differs from my levels of 1838, 25 feet, or 487 A. L. E What I consider to be the same bed at Perches's mill, on the Conoten, south of New Cumberland, about seven miles, south 65° east from Zoar, is 400 to 405 feet; A. L. E., 60 to 80 feet lower than at Zoar.

According to his figures, this seam is, at the tunnel, 495 feet, which, if he is right as to Zoar, is a rise of 33 feet, not in the direction of the supposed upward undulation, but in a direction parallel with it. By my figures, the coal is nearly level in this direction, as it should be along the line of bearing. If the canal can be relied upon as a base, this seam sinks regularly but gently to the east, and passes below drainage near Pekin 460 feet A. L. E., I cannot yet admit that the Rochester seam is the same as No. 6, at Zoar and the tunnel. I find two more beds between Massillon and Rochester, on the line of the Big Sandy, than I do on the line of the Pittsburg railroad, from Ravenna to Rochester. In the valley of the Tuscarawas, from Massillon to Bolivar, and along the old canal from Bolivar to Bayard I have constructed six geometrical triangles, in the planes of the strata, all of which show a regular *southeasterly dip*, in all the beds of coal and limestone that are visible. It is in, or under, the highlands of Carroll county, in this direction, that the report says the strata *rise* to the southeast. It also encourages the belief that seam *No.* 1, or the "block coal," exists here at a depth not too great for mining pusposes; whereas, the facts are, that it has been often sought for in boring, and there is no reliable proof that it has been found. The report of salt boilers about finding coal in old borings would, if they are reliable, give several beds *below No.* 1.

If the new Chambersburg and Rochester seam is the same as Zoar No. 6, it has been very much warped, and the sections are hopelessly confused among themselves for five miles east of Rochester to Lynchburg it is almost level, 549 to 529 A. L. E., nearly in the line of bearing, its inclination or dip being nearly south.

If this is No. 6 of the reports, the bed of limestone, which is here a short distance *beneath* it, and spreads over at least a township, around the Sandy canal summit, is wanting in the sections at the tunnel and at Mineral point.

This limestone bed is easily traceable, but after passing Hanover station along the railway, a little over a mile and a half, the coal gives out. It is here again beneath the Sandy summit, and the Yellow Creek summit, that the imagination of the chief geologist places another anticliniaal axis. To make the local geology easy, he causes the six subordinate beds of coal to rise underneath these summits, along a line of bearing that must be nearly east and west, and then to descend to Salineville, which is 200 feet lower than Hanover station.

If this is true, there should be no difficulty in finding these beds, in the ravines at the heads of the Sandy, the Little Beaver, and of Yellow creek, which the railroad crosses. I have often, and with tedious care, sought for them there, and have failed. The report does not say they have been found, but predicts that they will be.

Passing over the valley of the Sandy eastward to the valleys of the Little Beaver and of the Mahoning, the jumble of strata in the report is still more marked.

Coal No. 3, or the "limestone bed" of Holmes, Coshocton, Tuscarawas, Stark, Columbiana, Summit and Mahoning counties, is confidently asserted to be one and the same seam, over all this area. By my sections in those counties it is sometimes No. 3, at others No. 4, and in some cases No. 5, which, if I am not in error with my profiles, demonstrates the folly of forcing these local and irregular beds into one continuous plane. In places there are, beneath this seam, *two*, in others *three*, in others *no* beds of limestone, which does not raise any doubts of their identity in the mind of the chief geologist. In Freedom, Portage county, limestone No. 1 lies on coal No. 1. Coal No. 2 of the reports is wanting, or so thin and slaty as not to be known.

In Austintown, twenty-five miles southeast, coal No. 2 is 150 to 160 feet above No. 1, and has a limestone over it which, according to the report, should be limestone No. 2. Twenty feet above this limestone is another, resting on a thin coal, which should thus be No. 3 and the coal No. 4. On Yellow creek, in Poland, above both these limestone beds, is a thin seam of coal, and locally a third, generally a fourth, limerock. Now, in four of the seven sections given in the report of 1870, there is but one bed of limerock in all this vertical space from coal No. 1, to coal No. 5. The limestone strata are no more irregular than the coal, yet under the system and designations adopted in the report, the coal beds are marshaled in regular order with the same notation over a space one hundred miles in length.

The "Whan seam" of New Lisbon, or No. 5, is complacently affirmed to be the same as the "Rogers vein" of Yellow creek, and of another No. 5 in the valley of the Kilbuck. No such continuity exists in this vein extended westward. A much safer mode of designating these beds would be by name or letter; or, if they must be designated by numbers, to refer them to a fixed and well established stratum, like the great Pittsburg seam.

Of all bases, that of the floor of the Ohio coal series is the most changeable and uncertain. To reckon from it would of necessity produce confusion, because, although there must always be everywhere a bed which must be called "*No.* 1," it is not everywhere the *same* bed. By a triangle in the Whan seam, in the valley of Beaver, I found it to have a slight local inclination to the *northeast*, but farther north, on the line of the Ashtabula railroad, it dips regularly to the *south and east*, in conformity with the other beds. In the valley of Yellow creek, where I have numerous triangulations, there are also local irregularities; and there are beds, especially the Big or "Nisely seam," which are not *conformable* to others of the same locality. These levels disclosed the fact that the "Strip vein" at Hammondsville has local undulations, which the "Big vein" does not have, but they did not disclose a general system of waves in the strata, extending over large areas, bringing up lower strata from distant places in regular order. Strata can thus be made the sport of the imagination from the distant standpoint of New York, much more easily than from thorough observations in the field.

If there is a series of regular folds in these beds, such as are described in the report, how is it that the *reverse dip*, which must necessarily exist, has escaped detection by the level? Why is it that these wonderful undulations are seated always beneath the highlands, out of the reach of observation? If they exist they cannot be parallel with each other, or with the great Alleghany uplifts.

They must be in form like radii or fan-like, and must possess this other remarkable quality, that they cross the line of bearing, or are oblique to it. They must also controvert the structure of the same coal field in the Southeastern district, of which we have far more numerous and exact profiles, and fewer wonderful discoveries.

Coal seam *No.* 1, or the "block coal," in the valley of the Mahoning, is easily traceable, by open mines, from Mt. Nebo, around through Mineral ridge, up the valley of the Meander. I have in this space four good triangles, whose lines are five to thirteen miles in length, all of them showing a regular inclination *southeasterly.* Researches which have been made in the valley of the Mahoning, the Shenango, and the Beaver, toward New Castle, in Pennsylvania, much more thorough than those of this survey, show that in this direction, this seam *thins out* and is lost.

If this is so, those who bore for it in the valley of the Little Beaver will be disappointed. They will, of course, find seams of coal, but not the "block coal," or the "No. 1" of the Mahoning valley.

If I am right in my conclusions, there is in those of the report a fundamental error, which affects its practical value and reliability. The fact that his work was being scrutinized, has already induced the chief geologist very prudently to ignore some of the mistakes of his first report. If my criticisms shall have the effect to make him less reckless of opinions, and more careful in his conclusions between this time and the final report, they will have been of some value to the public.

GEOLOGICAL SURVEY.

EXAMINATION

BY THE

RETRENCHMENT COMMITTEE

OF THE

HOUSE OF REPRESENTATIVES

OF THE

STATE OF OHIO.

FEBRUARY, 1870.

COLUMBUS:
OHIO STATE JOURNAL BOOK AND JOB ROOMS.
1871.

GEOLOGICAL SURVEY OF OHIO.

Reply of Col. Charles Whittlesey to Questions put by the House Committee on Retrenchment Feb. 10th, 1869.

Question No. 1.—As to the advantages of the present geological survey provided it is done in accordance with the act of April 3d, 1869.

Answer.—In my estimation a geological survey is necessary to the development and prosperity of every State. Such a survey includes in its usual and largest sense, not mines and minerals only but all that is connected with metallurgy, agricultural, natural history fossil remains, and archeology or the antiquities of the country; and the publication of descriptions, figures, maps, profiles and models to illustrate them all.

In the first section of the act of 1869, the character of this survey is defined by the words: "A thorough geological, agricultural, and mineralogical survey of each and every county in the State." The amount of money appropriated to this object is, or may be $13,900 per annum, for three years, within which time the survey must be completed.

These clauses show that it was the intention of the Legislature to provide only for a *practical* survey, in reference to general geology; in a limited sense, to agriculture and to mines.

It is made imperative to appoint a chief geologist and a chemist, to whom may be added two permanent assistants, and as many local and temporary ones as the funds will allow.

The advantages of such surveys are in some cases, positive, and in others negative. If the State has mineral riches, their position, value and extent is to be determined. If she has not, or has them only in portions of her territory, the barren districts are to be determined, after which there is no excuse for her citizens to waste time and money in fruitless researches.

The advantages may also be again divided into those which are practical and direct and those which are general and scientific. In a full and complete survey, it is one of the objects to add to the intelligence of a people by furnishing them a knowledge of all the animals and plants that exist, or have existed, within the State.

This embraces full descriptions in Botany, Entomology, Ichthyology and Zoology, whether recent or fossil, and, if fully carried out, adds very largely to the expense.

Under the present act, no such survey could have been intended, for the appropriation is inadequate.

In this State coal is the leading mineral, being of more value than all the others.

The survey of 1838–9 shows that it may be found and mined in thirty-two counties.

The result of these disclosures was to direct attention to those counties, by iron and other manufacturers, and to points and cities where coal could be easily transported.

Before then all the pig iron of the State was made with *charcoal.*

In 1840, the entire product was 28,000 tons. In 1850 it had increased to 52,000, and in 1860 to 117,000 tons, doubling about once in ten years. More than half of this iron is now made with mineral coal; and it is wrought into bars wholly by the use of this coal.

In 1860 the total amount mined in the State was 1,265,600 tons.

According to the statistical report of the Secretary of State in 1868, it had then reached 2,000,000 of tons.

It is the work of the present survey to define, in more detail, the number, value and extent of our coal seams, and of such other valuable minerals as exist in the coal regions, or elsewhere, such as iron ore, fire-clay and water-lime. It should be determined for each square mile, and represented upon the map, whether the owner may reasonably expect to find coal upon his land. It is not the business of a geologist to locate and open mines, but to fix the general position of valuable deposits.

Private explorers and mining engineers must settle the details of opening mines, based on the public surveys and reports.

The iron ores of the State have become less important, since those rich magnetic and specular ores of New York, Canada, Lake Superior and Missouri have become accessible.

It is now the coal which determines the position of iron centers.

So far as is at present known, Ohio has the *best quality of coal*, for use in the stack furnace, in a raw state, of any country in the world.

By a mixture of the rich foreign ores with the purest of our home ores, a *better grade* of iron is produced here from raw coal than anywhere else, and at a cheaper rate for the same grade.

This "block," or furnace coal, is not co-extensive with the coal region, and is at present known only in small districts, but it is hoped and believed this survey will develop more of it.

The quantity of coal capable of making *coke iron* is literally inexhaustible, but the grade of coke-made iron is much lower than that made from raw coal.

Note.—What portions of the State will receive most, and what portions the least benefits of the survey?

The coal regions will evidently be most directly benefited; but with the present facilities for transportation, such benefits are reflected, and reach nearly all portions of the State.

To the West of a line nearly South from Huron river, on Lake Erie, past Columbus to the mouth of Brush creek on the Ohio, below Portsmouth, is the great limestone region of Ohio. These rocks in other countries have produced lead, gypsum, hydraulic cement, brine, and iron ore.

As yet, only gypsum and water-lime are known here. It is, except along the Ohio river, a flat country where the strata are seldom exposed. The rocks are almost everywhere concealed from view by the "drift formation." If minerals exist there, the typography of the country is very unfavorable to their discovery and to their being worked. In the flat regions mines must be worked through shafts, and the water raised by pumps; therefore, in order to be profitable, they must be very rich.

Some of the most extensive beds of iron ore in the United States are found in the "Clinton group," a formation of the upper Silurian System in western Ohio.

The "Dye stone" ore of Tennessee, Virginia and Pennsylvania, and the lenticular or "flax-seed" ore, of New York and Wisconsin, are in this formation. By geological analogy, it is probable this ore exists in Ohio; but whether it does, and if so will be of economical value, should be determined by the survey.

By one of those compensations which are common in Nature, those lime-rocks give rise to a more fertile soil than the strata of the mineral region proper

There is a belt of country about forty miles in width, through the centre of the State, between the limestone and coal, and thence along the shore of Lake Erie, in which minerals of value can not be expected. It is possible that the bitumen of the black shale may in places pay for distillation, for illuminating oil, as it does in Europe.

The fine-grained sandstone of the "Waverly group," and the coarse grained sandstone of the Portage and Chemung groups, in this district and along the Lake Shore furnish the best quarry stone in this or any other State.

There is no better building stone than "Grind Stone Girt," a stratum which crops out near the Lake shore along a line of 50 miles. It is in this belt, occupied by the so-called Devonian shales and sandstones, that are the principal sources of petroleum, or stone oil.

In Ohio it is only in limited distrits, that these oil producing strata are heavy enough, or are sufficiently open in texture to give a regular or valuable flow of oil.

The amount of money expended uselessly in the search for this mineral would have completed a perfect survey of the State.

No. 3.—Whether the amount appropriated is sufficient?

The sum of $18,960 per annum is not sufficient to carry out in three years time the examination required by the act.

I consider any reasonable sum of money, judiciously expended on such objects, to be as well applied as to any other public purpose.

Individually, my preference would be for a full and complete survey that should cover all the subjects I have above alluded to, and which would answer for all time.

In such enterprises I believe it to be more economical to make larger annual appropriations, and thus to hasten the period of their completion.

For the grade of survey, provided for in the law, including publication, and to be completed in *three years*, $25,000 a year is necessary; for a full and complete survey, including publication, $50,000 a year.

It is not advisable to spend much on the publication of annual reports.

The subject of printing and illustrations should be in the hands of the Board, with a restriction as to the amount.

When any department of the survey is completed, it may at once be put before the public.

During the progress of the survey, the members might be required to furnish, in writing, to the newspapers in each county, what valuable facts and discoveries they may have touching that locality, which would thus come at once into the possession of the community without cost.

No. 4.—As to amendments to the present law.

Here, as in all other respects, the question to be first determined is, what sum of money the Legislature shall see fit to apply to this purpose.

If it is to remain at the present figures, the greatest practical advantages will be derived from it, by dispensing with the permanent assistants, except a chemist, who shall be devoted wholly to analysis.

The balance of the fund, will accomplish more, if applied to the employment of local assistants, *under contract*, and the supervision of the chief, and who may be discharged when their special departments may be completed. I consider this to be the best arrangement for either a limited or a full survey.

The reason is that each person has his specialty, wherein his services are worth much more than in other departments, and the subordinates are more fully under the control of the Chief Geologist or Director, who is responsible for the work.

A limit might be imposed upon the pay and emoluments of the different grades of assistants.

Under the present law the chemist, who is the only permanent assistant, whose appointment is made imperative, was passed over.

In the organization, a system of absenteeism and want of personal attention to the work, has been countenanced, wholly at variance with the spirit and purport of the law.

The appointments are intended to be made on the ground of personal fitness, which implies personal attention to the work, and not its execution by deputy, or the execution of other duties, and the receipt of pay from other sources at the same time.

Under such a system, the business of the State is secondary, and if one or more members are authorized to consult their own convenience, all of them may do it.

Two of the permanent assistants have been faithfully engaged in the field.

As a special favor the Chief Geologist and the Agricultural assistant have been allowed to execute other appointments, and to receive pay therefor.

These defects may be cured by amendment, or by a resolution prohibiting the permanent assistants from engaging in other permanent duties while they are connected with the survey.

CHAS. WHITTLESEY.

HISTORY OF THE COAL AND IRON BUSINESS

FROM

CLEVELAND AS IT IS, 1872,

By Col. Chas. Whittlesey.

It will be sufficient for the present purpose to give statistics for periods about ten years apart, omitting most of the intermediate annual returns. The city and its industries have been in existence long enough, and are extensive enough, to develop a law or rate of increase. Returns of the receipts of coal by canal, from the commencement of the business in 1828, are given officially. This work was opened to Akron on the 4th of July in that year, and at least thirty tons of coal were shipped to Cleveland soon after. Philo Scovill, who was then proprietor of the Franklin House, was induced to put in grates and make an experiment with it, paying two dollars per ton. Coal was discovered in Tallmadge, a mile west of the Centre, as early as 1810.

It was visible in a small ravine on the land of Justus Barnes, where for many years blacksmiths from the adjacent county came and dug it from an open pit. The late Jotham Blakeslee, of Tallmadge, who only recently died, has often told me that he had procured it there from 1810 to 1819, and that no other coal was then known in Northern Ohio. As early as 1755, mineral coal had been discovered near Bolivar, in Tuscarawas county, by its being seen on fire, smoking and slowly burning in the ground, but I am not aware that it was dug or mined for use as fuel, in this part of the State, prior to 1810. My recollections of the place extend to 1819 or 1820, when my father, Asaph Whittlesey and Samuel Newton, purchased the property of Barnes, and soon drove an entry into the bluff. The seam was four feet thick, and from this time was regularly mined. Francis H. Wright not long after opened a mine on his land half a mile north, at the eastern base of Coal Hill. About 1826 or 1827, Henry Newberry, of Cuyahoga Falls, opened a bank at the Corners, half a mile farther north.

In the year 1838, Coal Hill, which was owned principally by Asaph Whittlesey, Daniel Upson and F. H. Wright, was put into a corporation under the name of the "Tallmadge Coal Company." A tram railway to the canal furnished most of the coal brought to Cleveland until 1845. As soon as the canal was made navigable to Lock 19, north of Akron, in 1828, Whittlesey and Newton took coal there with teams to be shipped, and the business was continued until 1832, when the canal reached the coal fields near Massillon, which were on its banks, and were worked by Cyrus Mendenhall. Professor Newberry, of the State Survey, has repeatedly claimed orally and in print, for himself and his father, the merit of originating the coal business of Cleveland. The late Mr. Newberry, of Cuyahoga Falls, took coal by teams to the canal in 1829, possibly in 1828, but was neither the originator, or a large operator, in that line, or any other branch of the coal business. He did not reside in Ohio prior to 1824, when the learned professor was about eight years of age; and even in 1828-9 was certainly too young to engage largely in such operations.

With the assistance of the late D. H. Beardsley (so long the collector of canal tolls at Cleveland), in 1853, I made and published a tabulated statement of the receipts of coal up to that year. That table is reproduced below, showing from what mines it was sent, and the annual amount of the business. No coal had then been brought in by railways.

STATEMENT OF THE AMOUNT OF MINERAL COAL RECEIVED AT CLEVELAND FROM THE YEAR 1828 TO 1852, INCLUSIVE.

Year.	From what mines taken.	No. tons.
1828	Tallmadge	30
1829	Tallmadge	708
1830	Tallmadge	178
1831	Tallmadge	294
1832	Tallmadge	431
1833	Tallmadge and Massillon	1,719
1834	Tallmadge, Massillon, and New Castle	3,347
1835	Tallmadge, Massillon and New Castle	1,776
1836	Tallmadge, New Castle and Trenton	2,944
1837	Tallmadge, New Castle and Trenton	6,421
1838	Tallmadge, New Castle and Trenton	2,496
1839	Tallmadge, New Castle and Trenton	4.901
1840	Tallmadge, New Castle and Trenton	6,028
1841	Tallmadge, Trenton and Middlebury	16,742
1842	Tallmadge, Trenton and Middlebury	16,339
1843	Tallmadge, Trenton, Middlebury and Youngstown	13,574
1844	Tallmadge, Clinton, Middlebury and Youngstown	18,901
1845	Tallmadge, Clinton, Middlebury and Youngston	31,136
1846	Tallmadge, Clinton, New Castle and Youngstown	28,133
1847	Tallmadge, Clinton, New Castle, Youngstown and Zoar	44,401
1848	Tallmadge, Clinton, New Castle, Youngstown, Zoar and Rochester	66,551
1849	Tallmadge, Clinton, New Castle, Youngstown, Cuyahoga Falls, Girard and Rochester	66,801
1850	Tallmadge, Clinton, New Castle, Youngstown, Cuyahoga Falls, Girard and Rochester	83,850
1851	Tallmadge, Clinton, New Castle, Youngstown, Cuyahoga Falls, Girard and Rochester	107,135
1852	Tallmadge, Clinton, New Castle, Youngstown, Cuyahoga Falls, Girard and Rochester	137,926
	Total	662.862

In Cleveland, the entire machine power is derived from steam, and the fuel for this and all iron manufactories is coal. The consumption of mineral coal is therefore a fair index to, and runs parallel with, iron business. By deducting from the returns of receipts by canal and railway, the exports foreign and coastwise, the balance represents very nearly the consumption within the city. Until 1838, when it was shipped only in small quantities, the receipts alone represent the consumption. It was not until after this, and after the Briar Hill coal began to reach here in 1843, that lake steamers could be induced to use it, and then after much persuasion and experiment. Firemen and engineers were decidedly hostile to it. Since 1845, it has supplanted wood on the steamers of the lower lakes. What is taken on board at our docks as fuel for them, cannot be separated from the consumption of the city:

Until 1845, the entire trade of the lakes in bituminous coal was in the hands of Cleveland dealers. About this time, possibly a year or two earlier, Erie began to ship coal, the joint receipts from the interior of the two places being only 45,136 tons. These two ports have hitherto had a monopoly of the the trade by lake, but it will soon embrace several other lake towns. Toledo, Sandusky, Black River, Fairport and Ashtabula have roads in construction, leading to the mines, the principal object of which is to bring out coal. What the present receipts at Erie are I cannot say, but in 1857 the amount was 126,159 tons. At Cleveland, in 1870, it was 901,600 tons, or three times that of 1857. If the business at Erie has increased at the same rate, her receipts should be now about 400,000 tons. When the other lake towns shall be engaged in the business, a still more rapid increase of the trade will accrue, and with it a general diminution in its cost.

By consulting the government census returns, the reports of the State Commissioner of Statistics, the annual exhibits published in our papers during thirty-five years past, of the commerce of Cleveland by canal, railroad and lake, *Leslie's Iron Manufacturer's Guide*, and the more complete publications of the Cleveland Board of Trade, a reasonably correct view of our general business progress can be obtained. Pig metal or cast iron is the basis of all forms of iron manufacture; but in regard to the article in this form, there is little local information. It is brought from so many directions and places, that it is difficult to trace out what is consumed here. We have every ten years, in the census, an account of its production throughout the state, of which I conceive one-third eventually enters this market in some form, either raw or manufactured.

As the *ratio of increase* for population, for the consumption of coal and the manufacture of iron go nearly together, having a mutual dependence on each other, I shall present all of them together from their origin, or from an early period, to this time. The census returns are the only reliable source of information in these particulars. As these returns appear only once in ten years, I have selected periods of comparison about ten years apart, for our local statistics.

GENERAL COMPARISON OF THE INCREASE OF COAL AND IRON BUSINESS IN OHIO, AND AT CLEVELAND.

Date.	Tons of coal mined in Ohio.	Tons pig metal made in Ohio.	Population of Cleveland.
1850	320,000	52,658	20,984
1860	1,356,700	105,500	43,838
1870	4,000,000	309,033*	93,718

Date.	Manf'd iron at Cleveland—tons.	Tons of mineral coal consumed at Cleveland.
1848	———	57,438
1858	21,950	93,219
1868	73,270	353,105

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*Of the pig metal made in Ohio, about one-third was made in Northern Ohio. The figures for 1870 show that 152,307 tons were made in Northern Ohio.

It is evident from this exhibit that throughout this State the business of mining coal increases at the rate of 200 to 300 per cent. from one census to another. The increased product of pig metal is very uniform, at about 100 per cent. in ten years. Cleveland augments her population at about the same rate. In manufactured iron and the consumption of coal, the rate is much more rapid. In 1869, the last year of the Trade Reports, the consumption of coal was 524,555 tons, and manufactured iron 92,425 tons.

Coal will soon be delivered at other points on the lake shore, and all business depending upon it will be materially enlarged in Northern Ohio. The table of distances which I here present, showing the principal lines over which it will be brought to the lake, is worthy of consideration. Hitherto, the only resource for *furnace coal* has been over one road into the Mahoning Valley. It is found at Massillon and near Steubenville in limited quantities, but has not been carried away from those places, to melt the ores that come into Ohio from Lake Superior. An inexhaustible field of furnace coal has recently been reached in the south part of Perry county, which before long will be a competitor with Mahoning Valley block coal. Although the distance is great, it has a dollar a ton in its favor in the expense of mining. Several roads are now being built connecting these mines with lake navigation. Of all the projected routes to the Perry county coal, the one by Zanesville is the shortest.

DISTANCES FROM LAKE PORTS BY RAIL TO THE PRINCIPAL COAL FIELDS.

Cleveland to

	Miles.		Miles.
Coventry	45	Salineville	88
Canton	64	*Steubenville	121
Silver Creek	60	Sandy Lake by Ashtabula	115
Millersburgh	87	*Youngstown	66
*Massillon	63	Sharon, Pa	80
Massillon by Grafton	74	*Straitsville, Perry County, by Zanesville	176
Atwater	56		

Toledo to

	Miles.		Miles.
Silver Creek	124	Youngstown	179
Massillon	139	*Sunday Creek	176

Fairport to

	Miles.
Youngstown	65

Ashtabula to

	Miles.
Sandy Lake	64

Sandusky to

	Miles.		Miles.
Silver Creek	79	Youngstown	128
Massillon	96	Shawnee Run by Newark	160

Erie, Penn., to

	Miles.		Miles.
Greenville	63	*Sharon	71

Black River to

	Miles.		Miles
Silver Creek	58	Youngstown	101
Millersburgh by Wooster	76	Straitsville	170
Massillon	76		

*Furnace coal.

These distances are not in all cases taken from surveys or railway guides, and may be subject to slight corrections.

ORIGIN OF THE IRON BUSINESS.

The enterprising settlers of the Western Reserve were also the pioneers of the iron business of this State. Clendenin, Montgomery & Mackay, of Youngstown, built the first furnace in Ohio, at the mouth of Yellow Creek, on the Mahoning, in 1808, within ten years after the settlement of that region. Before that time all the castings and all the bar iron required on the Reserve was, like the grindstones, brought from great distances, at a heavy expense. Iron was almost a precious metal. This establishment was what is called among iron masters a "pocket furnace," eight feet across the boshes, and about thirty feet high. It stood like all the old furnaces, against a bluff, and was charged over a bridge built from the bank to the top of the stack. Its ruins are still visible a short distance below the Mt. Nebo mine. It was, of coarse, a charcoal furnace, with cold blast, driven by water power, producing only a ton and a half to two tons per day. In 1809, James Heaton* built a refining forge on Musquito Creek, where is now the prosperous village of Niles, in Trumbull county, for the manufacture of bar iron with charcoal, from the pig of the Yellow Creek furnace, and which produced the first hammered bars of the State. The second furnace in the State was erected on Brush Creek, Adams county, near the Ohio river, in 1811. In 1812, Jame Heaton built a furnace at Niles. Daniel Eaton & Sons, in 1813 purchased the Yellow Creek furnace, and also built another on the sam creek, at the falls, two or three miles above. Thirty years afterwards th business of making iron, with bituminous coal, in a raw state, in th United States, originated in this vicinity. The history of this great industry is worthy of attention. About 1816, Aaron Norton, of Middlebury, near Akron, put a charcoal furnace in blast, using a water powe half a mile above the village. In 1819, Asaph Whittlesey built a forg on the Little Cuyahoga, a mile and a half below Middlebury, where th present railways cross that stream.

The new business soon began to develop rapidly in the Lake Shor region. Along the northern slopes of the sand ridges, which lie near t and parallel with the shore, are frequent beds and bunches of bog iro ore, deposited from springs that issue from the ridges. It is a lean ore o about 25 per cent., but makes a soft and valuable metal, especially fo castings. Most of it was run into stoves, kettles and other hollow war for domestic uses. These establishments are now in ruins, and thei localities have passed from the public remembrance. As most of thei proprietors needed capital, and however energetic they may have bee most of them were unfortunate in the results, I will do something to preserve their memories, by inserting a condensed abstract of the owners an situations of the old charcoal furnaces of the Reserve. They were n then, as iron works are now, a presage of personal wealth and position With the pioneer iron men it was an experience of toil, perplexity an risk, that more often ended in pecuniary ruin:

STATEMENT OF THE EARLY COLD BLAST FURNACES AND FORGES, OF THE WESTERN RESERVE, OHIO, WITH THE DATE OF ERECTION, LOCATION, NAMES OF BUILDERS AN OWNERS, AND WHEN ABANDONED.

ERECTED.		ABANDONE
1808	Yellow Creek, Trumbull county, Mackay, Montgomery & Glendenin.	
1809	Musquito Creek (forge), Niles, Trumbull county, James Heaton	1845.
1812	Musquito Creek (fuanace), Niles, Trumbull county, James Heaton	1857.
1813	Yellow Creek Falls, Dan. Eaton & Sons	1833.
1816	Middlebury, Portage county, Aaron Norton	1842.
1819	Little Cuyahoga (forge), Asaph Whittlesey	1850.
1824	Geauga Furnace, Painesville, Incorporate Company, in operation till recently.	

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* Heaton was the son of Eaton.

ERECTED.		ABANDONED.
1825	—Concord, Lake county, Incorporate Company, destroyed by fire.	
1825	—Perry, Geauga county, Thorndike & Drury	not known.
1825	—Madison, Lake county, Root & Wheeler	“
1832	—Madison, Lake county, Clyde Company	“
1832	—Elyria, Lorain county, Herman Ely	1835.
1832	—Conneaut, not known	not known.
1832	—Elyria (forge), Norton & Barnum	“
1834	—Dover, Cuyahoga county, Barber & Hoyt, Cuyahoga Steam Furnace Company—run until recently.	
1834	—Florence, Huron county, Ford, Wilkinson & Co.	1840.
1835	—Mill Creek, near Youngstown—not known	1850.
1835	—Middleburg, Cuyahoga county, near Berea, D. Griffith & Co.	1850.
1840	—Akron, Ford, Todd & Rhodes	1855.
1840	—Valley Forge, below Cuyahoga Falls, D. J. Garrett & Co.	1845.

CHANGE FROM CHARCOAL TO MINERAL COAL.

In July, 1845, Himrod & Vincent, of Mercer county, Pa., blew in the Clay Furnace, not many miles from the Ohio line, on the waters of the Shenango. About three months afterwards, in consequence of a short supply of charcoal, as stated by Mr. Davis, their founder, a portion of coke was used to charge the furnace. Their coal belongs to seam No. 1, the seam which is now used at Sharon and Youngstown, in its raw state, variously known as free burning, splint or “Block Coal,” and which never makes solid coke. A difficulty soon occurred with the cokers, and, as Mr. Himrod states, he conceived the plan of trying his coal without coking. The furnace continued to work well, and to produce a fair quality of metal. It was either a happy accident or a fortunate experiment.

At the same time Messrs. Wilkinson, Wilkes & Co. were building a furnace on the Mahoning, at Lowell, Mahoning county, Ohio, intended to use mineral coal from seam No. 1, on which they owned a mine, near Lowell.

A sharp correspondence occurred, in 1869, between the partizans of the Clay furnace, and those of the Lowell furnace, as to their priority in the use of raw coal. The credit of making the first iron with raw bituminous, or sem-bituminous, coal, in the United States, belongs to one of these firms. An account of the blowing in of the Lowell furnace, on the 8th of August, 1846, may be seen in the *Trumbull Democrat* of Warren, dated August 15, 1846, where it is stated that to “these gentlemen (Wilkinson, Wilkes& Co.), belongs the honor of being the *first persons in the United States* who have succeeded in putting a furnace in blast with *raw bituminous coal.*” According to Mr. Wilkes, writing from Painesville, April 2, 1869, this furnace was run with coke several months, but at what time he does not state. It is admitted that Mr. David Himrod, now of

Youngstown, produced the *first metal*, with raw coal, about the close of the year 1845, and has continued to use it ever since. The friends of Wilkinson & Co.claim that it was an accident, and a necessity, while their works were built and intended for raw coal Without attempting to settle the question to whom belongs the most merit for this first success, all iron masters, and every one who takes an interest in the enormous business which has risen from the enterprise and intelligence of these firms, must feel willing to regard them as public benefactors. There are said to be at the present time thirty-seven (37) furnaces, nearly half the number there is in Ohio, working on that fuel, on the waters of the Mahoning and the Shenango. Most of them have business relation with Cleveland. The metal produced is largely from Lake Superior ore; and, for variety of uses, has not its equal in quality in any part of the world, excepting only iron made with charcoal, from similar ores. That made with coke must, of necessity, be inferior in grade; but for rails and many other uses, there is a large market for second and third class metal.

PALEONTOLOGY AND THE MORAL SENSE.

There is no apparent reason why the study of fossil remains should have a demoralizing effect; but the statements I am about to give concerning two leading Paleontologists are decidedly suggestive. Perhaps the coincidence is accidental.

In the Ohio State Journal of April 2, 1872, *Prof. James Hall*, of Albany; presents himself as a volunteer, in the differences between *Prof. J. S. Newberry*, of Columbia College, New York; and myself. I will first allow these distinguished scientists, to exhibit themselves in their own words. After reading these extracts I think no one will expect me to be particularly tender of either of them.

EXTRACT FROM PROF. HALL'S LETTER.

"When the Wisconsin Survey was organized, he (Whittlesey), insisted on having a place, and managed to *bring such influence to bear on the Governor;* that I was compelled to yield in a degree. He finally narrowed his demands to $2,500 for an exploration in the Northern part of the State; but this, with expenses and incidentals, amounted to more than $2,000, (probably meant for $3,000), and all he ever did was not *worth* ($20), *twenty dollars*." (The italic is mine).

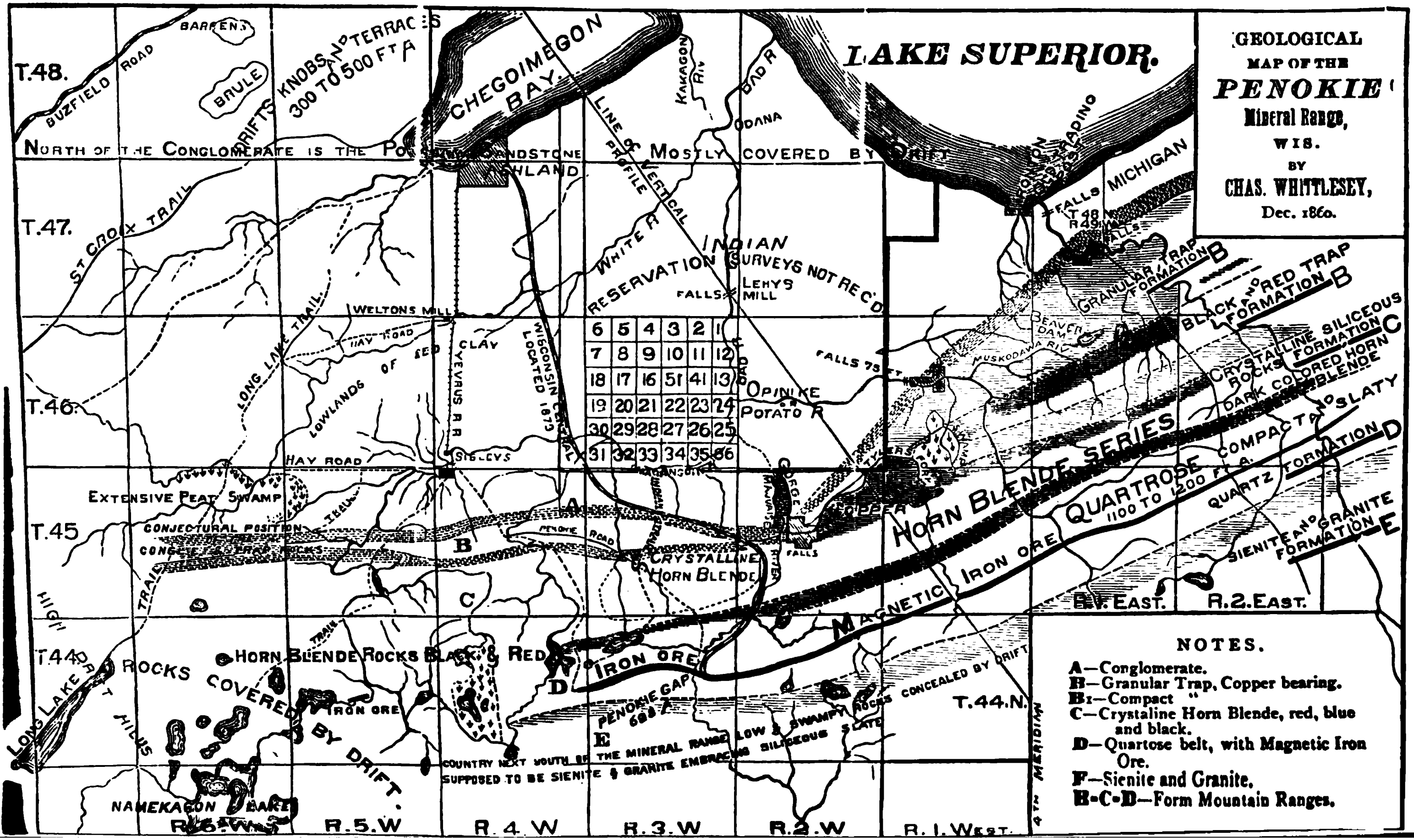
COMMENT.

A contract is before me, signed by *Prof. Hall*, dated June 12, 1860, for a Geological survey on the waters of Bad River, Ashland Co., Wis.; which was drawn up by him at Madison, a few days previous. The sum offered by him and accepted by me is (1,500), *fifteen hundred* dollars; which expressly covers all expenses. The work occupied me three months; with an assistant and two voyageurs; *whom I supplied and paid;* in accordance with the agreement. In December, 1860, my Report was made; embracing, according to my recollection, *eight chapters;* a Geological map, reduced from maps in the Land Office; and a profile. After witholding these papers from myself, and the State; from that time to this; he threatens to destroy them; unless he is paid certain claims; which the State has thus far refused to pay. An abstract of this report was published in the Proceedings of the Boston Society of Natural History, in 1863. Those who have read it, or shall examine my map, can judge how much malice, and how little truth; there is in the above statement of its value. It cost the State not $2,000, nor $2,500, nor $3,000, but precisely one-half the sum, which Prof. Hall asserts that it did cost. It is not true that "figures never lie." It is a country he has never examined, unless from the deck of a passing steamer; which I have thoroughly traversed on foot, and in birch canoes; but of which he assumed to know more than I do. A copy of the map, reduced by photograph, is here given and a brief notice of the iron belt.

The profile accompanying my map for the Wisconsin Report of 1860 is made across the stratification, from the village of Houghton, on Chegoimegon Bay, in a south-easterly direction, through the Dalles of Tyler's Fork, in Town 45, North Range, 2 West. The formations are lettered A, B, C, D and E, reckoning downward from the Potsdam sandstone, and conglomerate, A, to the sienite and granite, E. But for present use the profile will be taken along an ancient Indian trail, that leads from the mouth of Montreal River to Lac Flambeau, and the formations will be numbered 1, 2, 3, etc.

The provisional arrangement, which it is always necessary to make in the early stages of the examination of a new region, must, of course, be based upon the external characters of the rocks. In this case it is not only convenient, but proves to be a correct arrangement.

Owing to the indistinctness of the photograph, and the smallness of the scale, *one inch to six* (6) *miles*, the engraver has somewhat confused the outlines of the formations, and misspelled some of the names. The Wisconsin Central Railroad is put on of present date.


GEOLOGICAL
MAP OF THE
PENOKIE
Mineral Range,
WIS.
BY
CHAS. WHITTLESEY,
Dec. 1860.
LAKE SUPERIOR.
NOTES.
A—Conglomerate.
B—Granular Trap, Copper bearing.
B1—Compact "
C—Crystaline Horn Blende, red, blue and black.
D—Quartose belt, with Magnetic Iron Ore.
F—Sienite and Granite.
B-C-D—Form Mountain Ranges.
T.48.
T.47.
T.46.
T.45
T.44.
T.44.N.
R.6.W.
R.5.W
R.4.W
R.3.W
R.2.W
R.1.West.
R.1. East.
R.2.East.
4th Meridian
BUZFIELD ROAD
BARRENS
BRULE
DRIFTS
KNOBS AND TERRACES 300 TO 500 FT A
NORTH OF THE CONGLOMERATE IS THE POTSDAM SANDSTONE
MOSTLY COVERED BY DRIFT
CHEGOIMEGON BAY.
ASHLAND
LINE OF VERTICAL PROFILE
KAKAGON RIV
BAD R
ODANA
INDIAN RESERVATION
SURVEYS NOT REC'D
FALLS
LEHYS MILL
WHITE R
ST CROIX TRAIL
LONG LAKE TRAIL
WELTONS MILL
HAY ROAD
LOWLANDS OF RED CLAY
YEVRUS R R
WISCONSIN CENTRAL LOCATED 1873
SIBLEYS
BAD R
OPINIKE
POTATO R
FALLS 75
EXTENSIVE PEAT SWAMP
CONJECTURAL POSITION CONGLOMERATE & TRAP ROCKS
TRAIL
PENOKIE ROAD
CRYSTALLINE HORN BLENDE
GORGE
MAJVAISE RIVER
FALLS
COPPER
A
B
C
D
E
HIGH
LONG LAKE
FLAT HILLS
ROCKS COVERED BY DRIFT.
HORN BLENDE ROCKS BLACK & RED
IRON ORE
NAMEKAGON LAKE
COUNTRY NEXT SOUTH OF THE MINERAL RANGE LOW & SWAMPY ROCKS CONCEALED BY DRIFT
SUPPOSED TO BE SIENITE & GRANITE EMBRACING SILICEOUS SLATE
PENOKIE GAP 687 F.
MAGNETIC IRON ORE
HORN BLENDE SERIES
QUARTROSE 1100 TO 1200 FT. A.
QUARTZ FORMATION D
COMPACT AND SLATY
SIENITE AND GRANITE FORMATION E
GRANULAR TRAP FORMATION B
BLACK AND RED TRAP FORMATION B
CRYSTALLINE SILICEOUS ROCKS FORMATION C
DARK COLORED HORN BLENDE
BEAVER DAM
MUSKODAWA RI
TYLERS FORK
FALLS
T.48 R.2W
MICHIGAN
MONTREAL R
NONSUCH LANDING

The following is a general view of the structure of the formations in the descending order:—

FORMATION NO. 1.—*Potsdam Sandstone.*

On the Montreal River, *strike* north-east by east, in places N. 60° E.; *dip* north-west by north, 75° to 90°. It embraces four members, *a*, *b*, *c*, and *d*.

a.	*Sandstone Proper*, corrected for bevel, thickness	8,500 feet.
b.	Alternations of sandstone and black-slate, thickness	750 "
c.	Conglomerate, thickness, (A)	1,800 "
d.	Alternations of trap and sandstone, thickness,	800 "
	Total	11,850 "

This is not the entire thickness of the Potsdam at the mouth of the Montreal. The synclinal line, lies an unknown distance out in the lake, perhaps one-fourth of a mile, and whatever this distance may be, should be added to the above statement. At the Apostle Islands and in Chegoimegon Bay the dip is reversed, having a direction towards the south-east; but the line along which the change occurs is covered either by the waters of Lake Superior, or by drift. On the northerly side of the synclinal, the plunge of strata is much less in amount. It presents the case of nearly horizontal beds on one side, and of nearly vertical ones on the other. Following the outcrop along the southerly shore to the west end of the lake, and thence along its north-westerly coast, the dip is everywhere conformable, and to the south-east. By estimates and measurements on that shore, combined with those at the Montreal, I regard its total thickness to be not less, than fifteen thousand feet. No fossils have yet been found in the sandstone of the west end of Lake Superior. Its color is generally red, owing to the presence of oxide of iron. Where this is wanting, it is gray or a dull white, and in places mottled gray and red.

FORMATION NO. 2.—*Trappose, in two members.* (B B)

a.	Brown amygdaloid; dip and strike conformable to Formation 1; thickness along Lac Flambeau trail	3½ miles.
b.	Compact, red and blue	2½ miles.
	Total	6 miles.

FORMATION NO. 3.—*Hornblendic.* (C)

Compact, sub-crystalline and slaty; black, red and blue; strike N. 60° E.; thickness on trail	2¼ miles.

FORMATION NO. 4.—*Silicious, two members.* (D)

a.	Quartz, slaty and in layers; dark colored, but less than Formation 3; thickness variable; separated from *b* by a bed of magnetic iron ore and slate.	
b.	Quartz, slaty, in layers and beds; more compact and lighter color (gray and straw color) than *a*; novaculite; strike N. 60° to 65° E.; dip variable, 30°, 45°, 60°, 75° to the north-west; breadth across the edges on trail	3½ miles.

FORMATION NO. 5.—*Granite and Sienite, of Central Wisconsin.* (E)

Fifteen miles to the westward of the trail, on a parallel line from the mouth of Tyler's Fork to the Dalles, the total thickness of Formations 2, 3 and 4 is reduced nearly one-half. The diminution, however, comes principally from the upper member, *a*, of Formation 2, which tapers out in that direction very rapidly. Formation 3 is also somewhat diminished; yet Formation 4 is not materially changed in thickness.

CHARACTER OF THE ORE

It is of the black, fine-grained, compact variety, known as *magnetic iron ore*, sometimes called magnetite. It differs in many respects from the specular and hematite ores in Marquette county, Michigan, although at first view, before it is crushed or analyzed, the difference is not so noticeable. Magnetic ore is composed chemically of a mixture of the protoxides and peroxides of iron, and its powder is *black*. The specular and hematite ores are peroxides, and pulverize *red*, or redish brown. The ore of the Penoka Range is not crystalline, like that of Lake Champlain, but is frequently slaty, in plates of one-quarter of an inch to one and one-half inches in thickness. It is not massive like that of Marquette. It occupies, geologically, a bed, or *stratum*, between strata of quartz rock, the underlaying one being often slaty, like the ore, and fine-grained like novaculite. Layers and streaks of quartz are interstratified with the ore, and above is a bed of silicious rock, generally thick-bedded and compact. In all parts of the Range the geological order of the rocks is the same, all dipping to the north at various angles. All the members of the formation are everywhere present in the same order, though in some places more tilted up and dislocated than in others. It is easy, therefore, to determine the position of the iron stratum, even though it may be covered by sand, clay or gravel. It also extends downward below the surface, with the other strata, indefinitely, rendering the deposit strictly an inexhaustible one. The outcrop is in the bluffs, facing to the south. Its thickness varies from twenty to one hundred and fifty feet, the surface show or breadth of outcrop depending upon the sharpness of the angle of dip, and the local steepness of the mountain slopes. When the strata are more horizontal and the country more level, of course the beveled edges are broader. It lies not only in beds and thin slabs, but has regular joints, which form rectangular tables and blocks. It comes to the surface in so many places that the stripping will be light for a long time to come. The principal loose or refuse material will be quartz rock, which is easily distinguished by its white or grey color, from the ore, which is black. I cannot estimate accurately the cost of mining per ton, but think it will not exceed, on a large scale, that of the Marquette ore. As the mineral deposit is more regular, a mine or quarry can be laid out for large operations with more system. It will be a long time before it will be necessary to provide pumping apparatus for the excavations, there is so much ore above water level.

In quality, this ore resembles that of Sweden and Russia, from which the best charcoal iron of the world is made. There have been only a few analysis. They all agree in showing no foreign material except quartz, which is in a state of mechanical mixture. The ore separated from the quartz by washing, or by a magnet, is in all cases a pure magnetic oxide. When cleared of all foreign mixtures, magnetic oxide yields 72 40-100 of metallic iron, which is the highest per cent. of any ore of iron. There is a remarkable similarity in the ore, on different parts of the range, but that towards the western part appears to me to be most free from silex, and therefore richer in metal. From specimens which I collected for the United States Survey, soon after I discovered this deposit in 1849, Dr. Owen made an analysis of one which yielded 55 30-100 of pure iron, and which he says was apparently ten per cent. below the richest specimens. (See his Report to Congress 1852, p. 446.) A piece of slaty ore at Penoka Gap, analyzed by Prof. Cassels, yielded 55 88-100 per cent., and another of the compact variety 58 37-100. A selected specimen, analyzed by Chilton in 1859, gave of metallic iron 68 8-100 per cent.

MANUFACTURE OF CHARCOAL IRON.

The Bad river country has conspicuous natural advantages for making high grade charcoal iron on the spot. The northern slope of the iron and of the copper ranges, produces a heavy growth of hard wood, which is principally sugar tree, with some elm and birch.

On the upper waters of White River there is a *large supply of peat* and in other places peat exists in valuable quantities. It has long been used in Europe for iron smelting and produces metal of the same grade as charcoal. Improvements have been made in the use of wood, and other fuel, in iron mills and furnaces; by which soft timber and the refuse of trees can be turned to account. This region is destitute of limestone for flux, so far as at present known, yet it exists on Lake Superior, and can be delivered at low prices. The red clay of the region is calcareous, and may answer to supplement other fluxes in a limited way.

Prof. Hall further states: "After this; not satisfied; he (Whittlesey) with other kindred spirits; tried to break up the survey and finally did so."

COMMENT.

I am willing to allow these gentlemen full license of personal criticism and abuse; but I shall try to hold them to state the truth. I am also tenacious, when they undertake to suppress or appropriate my work; especially in fields they have neither the capacity, or inclination to explore.

Outside the fossiliferous sedimentary strata; and among the igneous and metamorphic rocks; especially as to their mineral contents; neither of them, are authority. Their speciality and their abilities; are acknowledged in generally geology, when connected with fossil remains. I know of no instance where a good paleontologist has been a reliable mineral explorer, or mining engineer. Those specialties are wholly diverse, and are so different that whoever succeeds in one, necessarily fails in the other. If Prof. Hall had explored with me the great northern wilderness of Wisconsin; which is underlaid by no fossiliferous, but only igneous and metamorphic rocks; I should not be inclined to yield my views to his.

The last survey of Wisconsin was organized in 1857 at a time when Prof. Hall was connected with two other surveys; but none the less desired more. The appointments were made in the statute and *not by the executive;* and the appointees were *Profs. Hall, Carr and Daniels.* With this survey and its appointments I had at that time; no connection or knowledge. On the part of Prof. Hall it was obtained like that of Prof. Newberry in Ohio; with a view to personal absenteeism; and to working by proxy. But the Governor and legislature of Wisconsin, proved to be less pliable than the executive of Ohio.

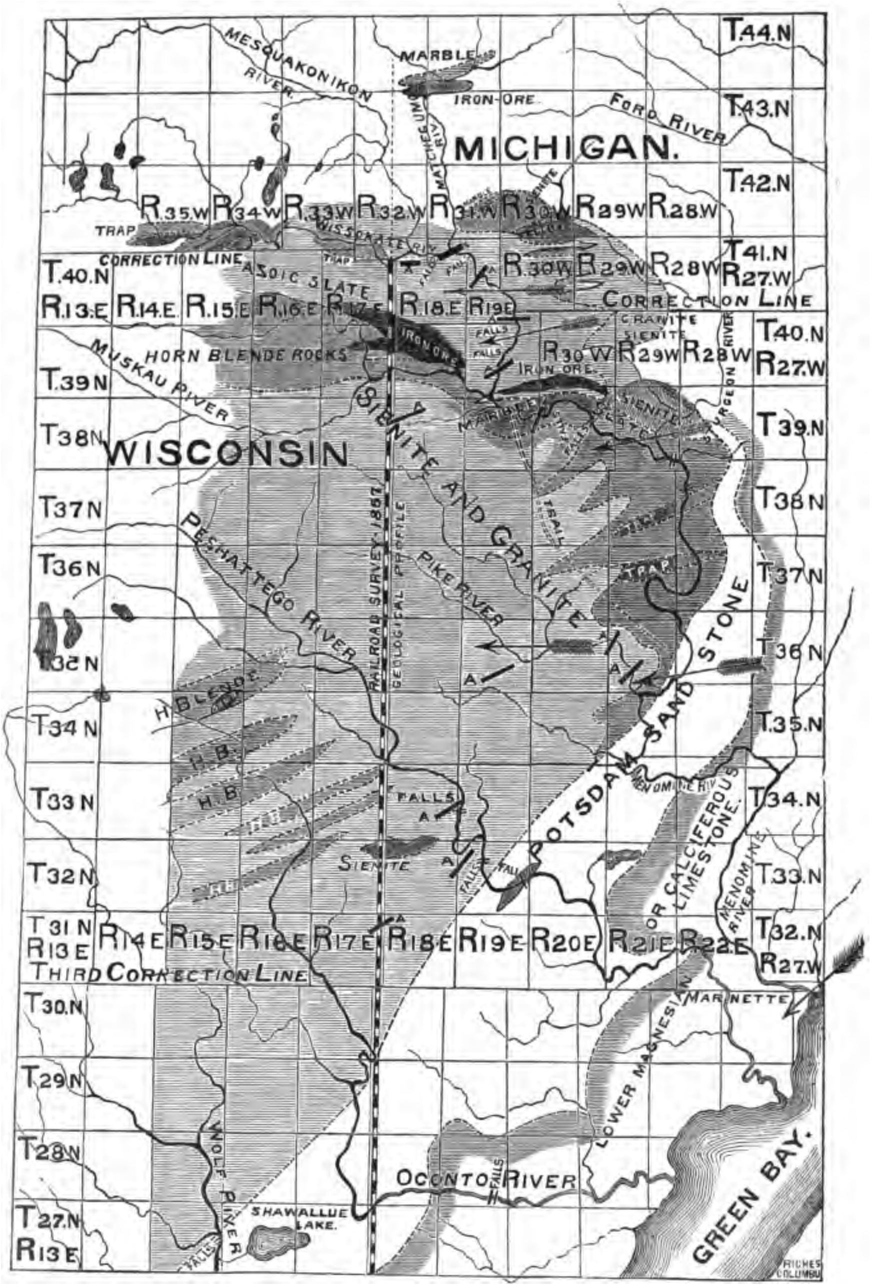
Under this law, nothing was done in 1857. In 1858 as neither Prof. Hall or Prof. Carr were inclined to take so unpromising a field; an arrangement, was made by them with *Prof. J. D. Whitney,* to work on the lead region; and myself, to explore in the unsettled iron regions of Northern Wisconsin; as their substitutes. The governor so far as I know had nothing to do with it. The region it was expected of me to examine; was a wide spread wilderness; occupied principally by Indians; much of it not surveyed into townships; and everywhere inaccessible by the usual modes of traveling. It was only by means of half-breed packers or voyageurs carrying everything in their canoes, or on their backs; that it could be penetrated at all. It was a work for which carpet geologists, had no taste; but who expected of others that as rapid progress; should be made as in the open prairie region; among settlements; with the usual modes of conveyance. This territory included nearly half the State.

From August to November, 1858, I examined the country between the Oconto and Menominee Rivers, and under this arrangement, I received from Profs. Carr and Hall the sum of ($1052) *ten hundred and fifty-two dollars;* of which I paid out in traveling expenses, equipment, sustenance, and the labor of three voyageurs the sum of ($512.73) *five hundred and twelve dollars seventy-three cents.* The assistant was paid by them.

A report was made by me in January, 1859, delivered to Prof. Carr; embracing I think (12) *twelve chapters;* with a profile along the line of the Railroad Survey, north from the Oconto, to the Brule Rivers; and a map of which I here present a copy from a reduction by photograph, which according to his valuation should be worth $20 more.

GEOLOGICAL MAP OF THE COUNTRY ON THE UPPER WATERS OF THE MENOMINEE, PESHATTEGO AND OCONTO RIVERS.

By Col. Chas. Whittlesey, 1859.



[Reduced by photograph to a scale of 4-10 of an inch to the mile.]

In this region, as in the Marquette, the original surface of the rocks was much changed by ancient glacial action. This tremendous abrading power acted more effectually upon the softer portions of the strata, like talcose slates and hematite ores, carrying such parts away more readily, and therefore they now represent the low grounds. Harder and more stubborn rocks, such as quartz, silicious trap and jaspery ore, resisted the ice force better, and now represent the knobs, cliffs and prominent hills. This is the reason why the least rich and the most silicious ores are the first, if not the only ones seen in surface explorations.

My first impressions, from such an examination, were not favorable for a large supply of workable ore; but the trenching done by the Canal Company, exposing the covered portions, threw new light upon this question. On the southern belt, in the vicinity of Smoke Lake, four bands of ore were reached, having from *six to twenty-eight* feet in thickness each, which analyzed from fifty-five to sixty-three per cent. metallic iron. The variegated marbles show themselves again on the Brule river, in T. 41 north, Range 15 east, near the south line.

Professor Pumpelly remarks as follows on the future of this region: "The great extent of the iron deposits, their freedom from injurious substances, the number of iron mountains that admit of cheap mining; the beds of limestone for flux; the presence of the best of hard wood, an advantage over Marquette of nearly one-half in distance to shipping, by a descending grade; are elements which seem to insure success."

"The analysis made by Prof. C. F. Chandler, proves the ores to be free of all ingredients, injurious to iron, and to consist only of oxides of iron with silica."

The southern belt is now known to have a length of nearly thirty miles. In the Pine river and Lake Komon region, its width cannot be less than two miles. In his general remarks the Professor, who is not given to excitement in regard to minerals, becomes somewhat enthusiastic, and says: "this great area of iron property, cannot long be idle. Its value, should it equal my expectations, is too great; and the demand for ore is increasing too rapidly for it to remain undeveloped."

EXPLANATIONS AND CORRECTIONS.

The heavy straight lines A A A — indicate the direction of local ridges and uplifts.

Arrows show the direction of the glacial furrows and stria.

Fine lines on the original, showing the strike of the lamina of the slates, omitted on account of the reduced scale. For Shawallue read Shawano.

On this scale the complicated outlines of the formations cannot be made distinct. In T. 42 N., R. 35 W., Michigan, there are heavy beds of marble and quartz, on the Brule or Wisokate River, which are not lettered. To make the geology of this interesting region clear, requires detailed maps on a large scale, by townships; a sample of which accompanied my report of 1858-9.

Since that time the iron ore shown near the Menominee River opposite the mouth of the Muskau or Pine River, has been traced to the east and to the west, many miles each way, for which see the reports of Prof. Pumpelly and Major Brooks.

On the Wisconsin side no exploitation has been done, but the surface indications become more and more assuring, as the country is more fully examined.

The marble and quartz, which are the geological associates of the iron of this formation, are prominent and certain guides for the explorer.

About three miles north of the great Smoky or Bekeunnesec Falls of the Menomine river, is a hill of iron ore, situate on Sec. 30, T. 40 north, Range 30 west, Michigan meridian. Most of the rocks in this township are covered by a heavy deposit of sand, gravel and boulders, and are therefore seldom visible; but the magnetic needle is greatly disturbed, indicating the general presence of iron ore at unknown depths. The greatest deflection occurs between Antoine's Lake and Smoke Lake, where it is sometimes almost reversed. South of Smoke Lake, on the township line, are heavy beds of blue, red and greenish white marble, which is again visible on the Menomine, near the mouth of Pine river.

The other rocks are azoic slates of the Huronian and Laurentian systems, of the Canada Geological Reports—the oldest of the geological series, and the same as those in the Marquette iron district. Those slates are generally regarded as talcose and magnesian; but analyses which I caused to be made by Prof. Cassells in 1858 showed them to be mainly silicious, and to contain everywhere the oxide of iron. There are here the same bands of compact quartz, and of crystalline marble, as are found at the mines around Negaunee. Professor Pumpelly, of Cambridge, examined this region in 1867, to locate lands for the Portage Canal Company. He concludes that there are two mineral courses or belts of ore, bearing nearly east and west, which he denominates as the "northern" and the "southern" belts. Near the Wisconsin river, on both banks, the drift bluffs are heavy, concealing the rocks for several miles, except occasionally in the channels of water courses. On the Wisconsin side, in Sec. 22, T. 39 north, Range 18 east, at the falls of Pine river, iron ore is visible, similar to that on Sec. 30, east of the Menomine. It is also visible on the range line between 17 and 18; on the south-east quarter of Sec. 13, where it is slaty and magnetic. On the intermediate sections, both magnetic and specnlar ore has been seen. Three miles north is a small lake, which the Potowatomies call *Lake Kómon*, signifying, as I am told, Iron Lake in their language. On the east of this water the bluff rises about an hundred feet, but on the summit land the drift gravel is not very heavy. Beneath it the ore is frequently seen for a distance of two miles. Little was known of the southern belt, east of the Menomine, with certainty; until trenches were cut in the gravel and boulders across the strike of the strata, in 1867.

This is a region that promises a large supply of both magnetic and specular iron ores when it is reached by railways.

That part of the Menominee iron district east of the river, is given from my visit in 1850, on the government surveys, in Michigan in charge of Messrs. Foster and Whitney.

Having obtained possession of this report Prof. Hall still retains it, and has made the same assumptions of a superior knowledge of this field of azoic rocks which he has never examined, as in the case of the Bad River region.

In 1859 I had no connection with the survey of Wisconsin. That of 1860 has been already stated in part. During the session of 1859-60, the *Legislature* having become dissatisfied with Prof. Hall's absenteeism; and the little practical value he was giving to the survey, *passed a law, directing him; not the Governor; to contract with Prof. Whitney and myself; to continue our work.*

How can it be true, as he says; that by influence with the Governor I compelled him to give me a place? In this broad misstatement; he cannot plead ignorance; for all these facts appear in the preface to Vol. 1 of a report written by himself, and published in 1862.

The State of Wisconsin was more critical than Ohio, and insisted upon something more than mere Paleontology, wrought out comfortably at his home, on the banks of the Hudson. I know of no other reasons for their refusal to meet his demands; and for the final discontinuance of the survey.

In 1861-2 I had enough other occupation in the Southern States; less congenial, but more necessary to the public, than Geological surveys.

I now give to Professor Newberry a hearing.

In the same Columbus paper, he makes the following assertions:

"In the organization of the corps now engaged in the (Ohio) survey, I (not knowing him as well as I do now) *nominated him as first assistant Geologist. He, or his friends for him, declined to take any* other position on the survey, than that of Chief; of which he felt quite sure. After my appointment was announced, with a *great show of virtue*, he proclaimed he would have *nothing to do with a survey so corruptly* organized; but within a few weeks *thought better of it*, and wrote, asking to be permitted to work up the *topography of the State* for \$4,000."

COMMENT.

It would be very difficult to embrace in the same number of words a greater amount of untruth. No proof can be furnished, worthy of belief, to show that I declined to have nothing to do with the survey; although I was fully informed of the intrigues of Newberry and Klippart in connection with it. It had been the cherished hope of a life-time. My note-books contain a large part of the materials, for the report, I proposed to make. But I did not propose to owe a place in it to a *bargain* with a party so unscrupulous in the pursuit of places. This difference seems to be impossible for him to comprehend.

On his part, and that of Klippart, it was not simply for one full office and its pay; but for *two full offices* and full pay for both. This was the object and purpose on their part. Both of them offered me assurances of support, in case I would promise them positions. I simply declined to give any pledges. They found means, however, to enlist the services of the *Lieut. Governor*, as a partner in the scheme, the three laboring in person at Columbus; to which the *Governor* became a willing victim. The evidence which supports these statements I have heretofore made public. It is to be found, principally, in the public utterances of *Lieut. Governor Lee*, of *Prof. Newberry*, and of *Klippart*. (See Appendix.)

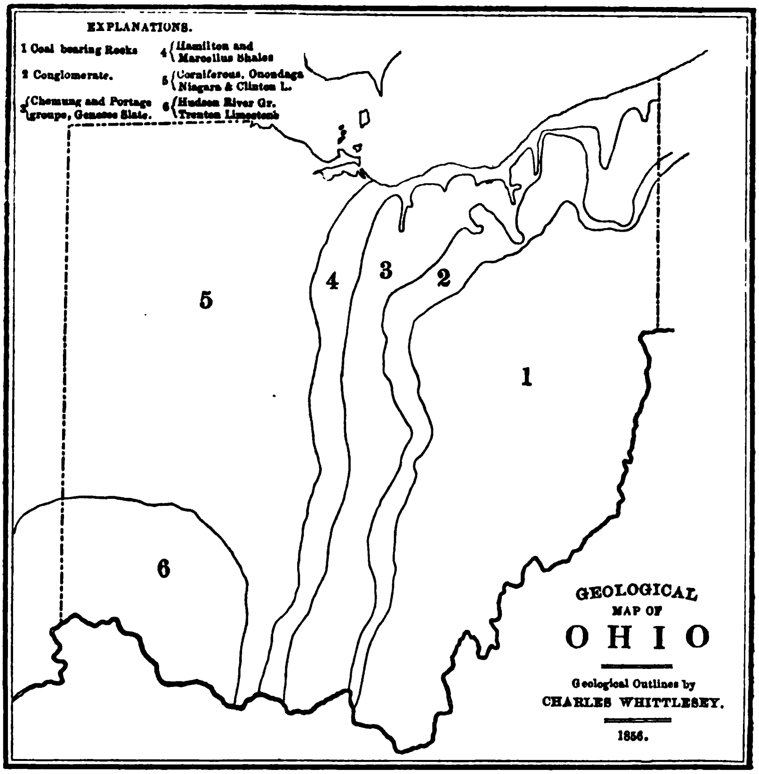
I allow *Prof. Newberry* the same latitude as *Prof. Hall*, to be severe and malicious; but shall hold both of them to the facts. My proposition to Gov. Hayes is in these words, in a letter dated May 10, 1869: "It seems to me that my explorations in the north-eastern counties of Ohio, extending through a life-time; should not be thrown away; I propose to do the *physical geology* of *twelve counties*, Starke, Wayne, Columbiana, &c., for \$500 per county, which includes all expenses; payments to be made quarterly, at the rate of \$2,000 per year." It was further stated that the work should be performed to the satisfaction of *Professor Newberry*. The Governor replied that he had placed the matter in his hands. I did not propose to have an "*appointment*" on the survey, but to *make a contract*; in which my work and duty should be clearly defined; as in the case of the local assistants, to have no connection with the chief Geologist; except as an arbiter, on the sufficiency of the reports. Nothing was said of the topography of the State. Any competent judge who examines the reports of Prof. Newberry on those counties, will find that it has cost the State far more than my offer would have cost. I have already published my views on the errors and imperfections of his work in these counties, showing hopeless confusion in the order of the strata.

Next, as to my "*nomination*" as Assistant Geologist. By our law the *Governor* made the appointments of assistants; after advising with the Chief Geologist. How could he have made a "nomination" before his own appointment was made; and after this, I was never approached on the subject; by him or any one else.

If he means to assert, that when he was Chief Geologist, and had the proper authority, he made any such offer to me, directly or through friends; I give it the fullest and flattest contradiction. Neither did I authorize any one to receive or reject such a proposal. Nothing can be substantiated on this point, by proof, better than his own assertion, which I have more than once shown to be wholly unreliable. The nearest approach to anything having a resemblance to what he states, is a *promise* by him before any of the appointments were made; that if I was Chief Geologist, and would guarantee him the Paleontology; he would guarantee me the place of first assistant, if he got the survey. It is an abuse of language intended to deceive, to call this piece of electioneering; a "nomination." It was simply a proposition for a *bargain;* to make sure of a place, and was made for this purpose to me and to other competitors. In case I had the disposal of the Paleontology of the survey, and in case he was eligible to office in Ohio, which is very doubtful, I should have given it to him, but did not propose to join the cabal he had formed at Columbus; and farm out places on the survey in advance. *J. H. Klippart*, a notorious intriguer, quartered for life in the State House; was like Professors Newberry and Hall, greedy of more places. He addressed me through a common friend, asking a pledge for a place on the survey; threatening to prevent the appropriation, if he could not have it; and stating that if I should not promise it, Newberry would. (See Appendix.)

Any one who wishes to probe this matter, will find the material facts, in a report of the Committee on Retrenchment of the Lower House, made in January, 1870, from which I make a short extract.

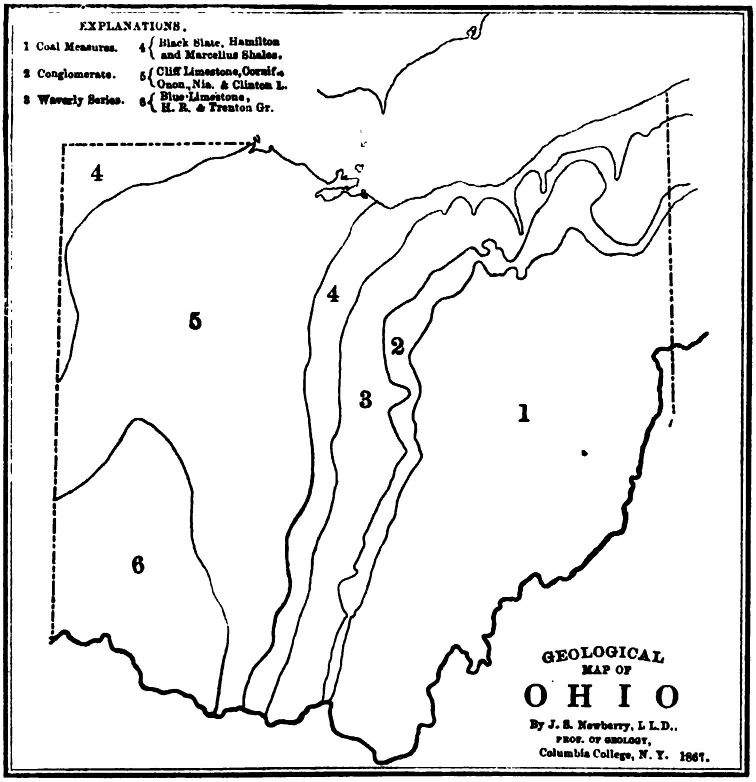
"Your Committee conceive that the appointment of Prof. Newberry, as well as that of Prof. Klippart, who were and still are holding lucrative positions, the one in a college in the city of New York, and the other an official position in Ohio, to have been ill-judged, reprehensible and humiliating to the State. To see one of the principal offices in the State farmed out and the duties performed by others, is an anomaly in the history of the State. Your Committee cannot too highly condemn such a practice, which they believe to be illegal and in violation of the Constitution and laws of this State."


EXPLANATIONS.
1 Coal bearing Rocks
2 Conglomerate.
3 Chemung and Portage groups, Genesee Slate.
4 Hamilton and Marcellus Shales
5 Corniferous, Onondaga Niagara & Clinton L.
6 Hudson River Gr. Trenton Limestone
1
2
3
4
5
6
GEOLOGICAL MAP OF OHIO
Geological Outlines by CHARLES WHITTLESEY.
1856.

I do not claim it as a "*show* of *virtue*" that this mode of securing such appointments, does not suit me, and so replied to him. In the city of rings, and perhaps to a professor in Columbia College, such proceedings, may be considered honorable, and even smart, but they have here proven to be a grievous fraud on the people, and the treasury of Ohio.

Although I have repeatedly referred to this transaction; and the similar one embracing Klippart, as a piece of favoritism and corruption; no one has heard me state, as the Chief Geologist affirms that I did, that I would have nothing to do with the survey. I did on the contrary propose to have a connection with the survey, on the plan above referred to; the original of which is probably in the Governor's office at Columbus and can be verified. I have often said. however, and repeat it now; that to accept the place of "assistant," to be under his control; as to the field of action, subject to his propensity, to absorb the labors of others, to work at $1800 a full year, while he drew $3000 for half that time; was a little more than I felt inclined to do. After twenty years' acquaintance with his work in economical geology, I found it to be a continuous failure, and his subsequent publications relating to the minerals of Ohio; fully confirm this view. He has officially recommended the *Ellershausen process*, for iron making; which iron masters universally discard, after having invested large sums of money in it. West of the Alleghanies there is but one exception, which is a firm induced by his report to purchase at high figures a mine of worthless sulphurous ore in Canada; which can be worked by no other process. He has commended the *Barron process* for making steel, from cast iron, without change of form; which is for a valuable grade of metal, wholly impracticable. He indorsed a patent *hollow drill*, for exploring for coal; which has not proved itself of value, for that purpose anywhere. He takes the ground that petroleum is now being produced, in the rocks; while all experience shows that it is a mineral, and like all other minerals disappears as fast as it is worked out; and is not replaced.

The coal beds of North-eastern Ohio, so far as he has shown a knowledge of them in the reports hitherto made; are not properly represented, either in number or position. As these strata embrace nearly all the valuable minerals of Ohio; their development was the prime object of the survey. They demand the earliest attention, and the earliest place on the reports; but after three years of patient waiting, the details of the principal North-Eastern coal counties; which have been wholly under his control; have been witheld from the public until the final report. A volume of *Paleontology* was promptly ready, and presented to the first Legislature which met after the survey was organized.


EXPLANATIONS.
1 Coal Measures.
2 Conglomerate.
3 Waverly Series.
4 { Black Slate, Hamilton and Marcellus Shales.
5 { Cliff Limestone, Cornif. Onon., Nia. & Clinton L.
6 { Blue Limestone, H. R. & Trenton Gr.
4
4
5
2
3
1
6
GEOLOGICAL
MAP OF
OHIO
By J. S. Newberry, L L.D.,
PROF. OF GEOLOGY,
Columbia College, N. Y. 1867.

Were the practical results of the survey retained by him in order to compel the Legislature, to continue the survey in his hands, or to escape criticism and correction? I should hardly be willing to hazard a suspicion of such trickery, if I had not had the following experience. Loose ideas of personal honor do not spring up in a day, and they are legitimate cause of suspicion. They are a part of the character; and if they are cultivated, soon permeate all our actions, showing themselves, through the best laid plans of concealment.

In 1863-4, while he was Sub-Secretary of the Sanitary Commission, Professor Newberry was generally suspected, at Cleveland and at Cincinnati, to be squandering the charities of the Nation, by giving fat places to his relations. He asked and received my assistance in his defence.

In 1866 he was boring for a professorship in Columbia College, New York, which he has succeeded in retaining, and at the same time, in making the additional grab, of the Ohio survey. He asked and received my assistance in obtaining this professorship. In 1867 or 1868 he procured of me a copy of my Geological Map of Ohio, published in 1856, and without giving me any information of the use he was making of it; or any where giving me credit; issued it as his own, in Stebbins' Atlas of Ohio. Copies of both, reduced by photograph, are here inserted; and I leave every one to judge whether this is not gross plagiarism.

At this time he professed to be a friend. I have had enough of this style of friendship. It is more dangerous; than open warfare. Most persons having received so many favors from the Executive, and experienced so much forbearance from the Legislature, would have felt under peculiar obligations to act with an eye single to the interests of the State. In this case the practical objects of the survey have been subordinated to the special and scientific, so far as his personal work is concerned. What relates to the details of mines and minerals in his district has been kept back, to the last and the subject of fossil remains and general geology constantly brought to the front, and pressed for publication.

At the first meeting of the Assembly after the survey was organized he presented a volume of paleontology, which the proper committee of the Senate declined to print. Two succeeding Legislatures met, but the economical geology of his district, comprising most of the counties to which I have referred, was still unreported. This was work that could not be done in the lecture rooms of Columbia College, and was, under the vicious organization of the survey necessarily postponed.

I close by calling attention to a close parallelism in the traits of the parties I have in hand. Both are distinguished as paleontologists, and regard this specialty as the highest grade in geology. Both assume to treat with confidence subjects which are outside their specialties, and in which they are not authority. They exhibit the same strife in getting control of surveys which they expect to execute by proxy, and which they load down with paleontology. They have the same eminent genius for wire-pulling and the same audacity of assertion. There is a common distrust and want of confidence on the part of their associates, and subordinates, owing to a common practice, of making the greatest possible use of the labors of others, with the least possible acknowledgment. A scientific reputation honestly earned is an achievement to be proud of. If it is built up by systematic acquisitiveness and appropriations, it loses largely of its value. But the number is happily few, who strive for it at the expense of their moral obligations. Acquired by such means it cannot be permanent. It only requires time, contact and publicity, to strip it of its pretensions. I think I have shown that they are willing to accept the consequences of a strain upon the moral sense, if necessary to their success, or to gratify their malignity; and it will not be consoling to them, that most of the proofs I use, are furnished by themselves; another portion of which is given by way of Appendix.

CHAS. WHITTLESEY.

CLEVELAND, December, 1873.

APPENDIX.

On the *6th of April*, 1869, Prof. Newberry wrote as follows:

"I am a candidate for the position of Geologist so far as this, I shall accept the position if it is offered me, though *I have made no efforts to secure it by petitions or recommendations.*" (See Report of Committee, page 18.)

"I did nothing of the kind, but rested my case on a simple announcement to the Governor, through a common friend." (See his pamphlet, page 3.)

In direct opposition to this are the following statements:

Lieut.-Governor Lee, a friend and partisan of his, on the 14th of April, 1869, said in a public speech at Cleveland: "No sooner had I signed the bill for a geological survey, (passed April 3d), than I caused the telegraph to whisper in the ear of Prof. Newberry at New York, and in less than forty-eight hours (April 5th) he stepped with me into the Governor's office." (See Report, p. 18.)

A gentleman who had access to the executive office, whose name cannot consistently be used without his consent, wrote to a friend in Cleveland soon after the appointment of Prof. Newberry had been secured, as follows: "*He had on file exceedingly strong recommendations* from a large number of the most scientific men in the country." "The papers of Prof. N. had as good a case, as it is possible to make in the *presentation of his claims.*"

LETTER FROM DR. THEODATUS GARLICK.

CLEVELAND, Feb. 21st, 1870.

Col. Charles Whittlesey:

DEAR SIR: Your favor of the 18th ultimo is read, asking for a copy of J. H. Klippart's letter relating to the appointments of the Geological Survey of the State.

I have either lost or mislaid that letter. I can, however, give you the substance of it, and very near the language of it, from memory. The letter was an answer to one I had written him a short time before the Legislature made the appropriation for the survey, in which I requested him to use his influence to get you appointed Chief Geologist. In it I stated that if you got the appointment you would give the Agricultural department to Dr. Townshend, supposing this would be gratifying to Mr. Klippart. Mr. Klippart replied that he wanted the Agricultural department himself, and that Prof. Newberry wanted the appointment of Chief Geologist, and that by giving his influence for Prof. Newberry he would be securing his own appointment.

Mr. Klippart expressed himself with some warmth on the subject of his own appointment, saying that if any person supposed that the duties of his office were mere routine they were quite mistaken, and that if he could not get this appointment he could prevent the appropriation being made for the contemplated survey. This was not the exact language he used, and probably is not, but very nearly so, but it correctly expresses the ideas contained in his letter. I may find the letter, and if I do, I have no objection to let you have it.

Respectfully, yours, etc., T. GARLICK.

STATEMENT OF PROFESSOR LESQUEREUX.

(Page 12 of Committee's Report.)

"From this it is easily understood that a State Geologist should reside at the capital, or have his office where he can be found when not occupied in field work."

"But if appropriations are made merely for the benefit of a few individuals backed before the Legislature by influential friends, these surveys are soon interrupted by general indifference, the people considering the cost a mere loss to the State."

EXTRACT FROM THE OHIO STATE JOURNAL.

(April, 1869.)

"It seems entirely proper that the Senate should decline to confirm the appointment of Prof. Newberry as State Geologist, notwithstanding his eminent fitness for that place, until the promise of that gentleman is given that he will resign the professorship he now fills in Columbia College. The State desires the whole time, the undivided labors and the entire energies of whomsoever it makes its Chief Geologist, and these are what it pays a liberal salary for. It is reported that Prof. Newberry has said that he would rather be Geologist of Ohio than be *President of the United States*. If he rates the honor so high he can certainly afford to give up a professor's chair in a New York college. One cannot serve well two masters."

ON FLUCTUATIONS OF LEVEL IN LAKE ERIE.

BY COL. CHARLES WHITTLESEY,
CLEVELAND, OHIO

(From the "Canadian Naturalist" for April, 1875.)

In this paper I present very little in reference to fluctuations of the surface of Lake Erie, which I have not published heretofore. My principal object is to place on record a résumé of those publications, for future reference. The subject was taken up simultaneously in 1838, by the Geological Survey, Ohio, in charge of Professor W. W. Mather, and of Michigan under Dr. Douglass Houghton. When the Survey of Ohio was disbanded in 1839, I continued to make occasional observations, and to collect those made by others, until 1859; when the Lake Surveys of the Government, being then in charge of the late General Meade, adopted a general system of water registers. There have been on each Lake since that time two Meteorological Stations, where readings are taken each day of the height of the water, and all phenomena connected with its fluctuations. These readings will in due time enable the officers of the Survey to discuss the subject, on the basis of reliable facts; from which alone philosophical conclusions can be reached.

But prior to 1859 enough had been determined to show, that there is an *annual* rise and fall of the waters of the Lakes, analogous to the high and low water of large rivers, and due to precisely the same cause.

From the head of Lake Superior to the mouth of the St. Lawrence, the channel must be regarded as one great river with expansions, which is raised by the surplus water of the rainy season, and depressed by the dry season. It is simply the *balance between rain fall and evaporation* over the entire valley of the Lakes; embracing 300,000 square miles. When these two opposite factors shall be obtained by observation, the stage of water can be predicted with as much certainty as the probabilities of the seasons, can be deduced from observations on general meteorology. Both follow a law and are nearly parallel to each other. Both run through cycles of change, returning in periods that are closely similar but which are not regular.

In regard to what I have designated as the general or *secular* changes of level, as distinguished from the *annual*, the former results form the yearly balances. If the annual fall of water equalised for the entire Lake Country is above the average, there must be an accumulation. If it is less, there will be a depression. When several years are on the side of wet, the rise continues each year showing an increase of height, as it was from 1819 to 1838; amounting to a little more than *five feet.* Then a rapid change of the seasons occurred, on the side of drier and more evaporative weather. From 1838 to 1841 inclusive, taking the mean water of each year as a plane of comparison, the water fell 4.15 feet.

Since 1819 the water has not been permanently as low; but in 1846 it reached a point 4.77 below 1838, or within five inches of extreme low water; as at present known. There are, however, causes in operation that increase the suddenness of the discharge of water from the Lake tributaries into the Lakes and thus tend to increase the height of water. If these excessive discharges should occur when other circumstances are in favor of high water, the lakes will reach a higher stage than has been yet known. Thus it it may occur, that the range between high and low water may be greater than *five feet,* and the mean level be somewhat different from what we now put it. For the present it is fixed at two and a-half feet below the flood of 1838; which is five hundred and sixty-four feet above mean tide water at Albany, New York. The city directrix or zero of city surveys, was fixed by an ordinance in 1854 at high water mark of June, 1838, which is also made the zero of most of the railway surveys in Ohio. In a note there will be found some of the bench marks established by the City Engineers.

These two classes of fluctuations, the *annual* and the *general* or *secular,* must not be confounded with those which are temporally due to storms, variation of atmospheric pressure, and aerial movements or undulations; not yet fully understood, and which I have called "*transient oscillations.*"

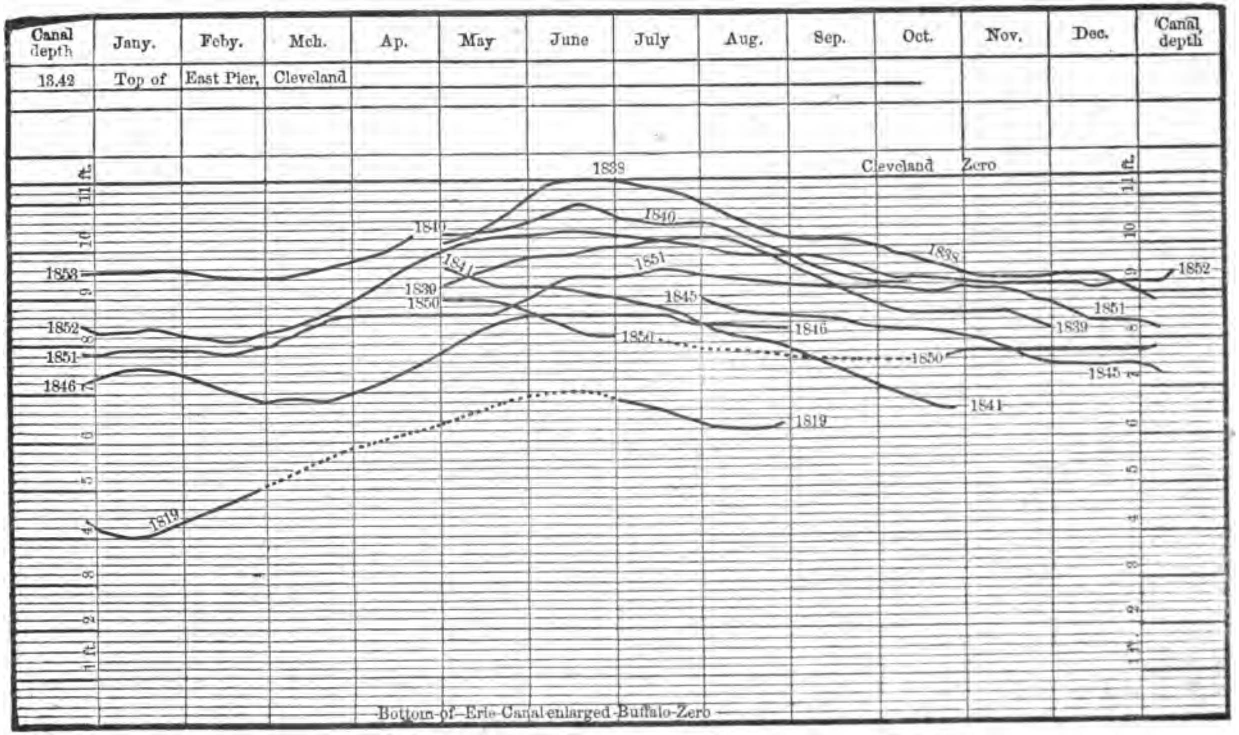
Prior to 1859, there were daily registers kept at Cleveland for only two short periods. The first was by George C. Davies, under the direction of the Government Harbor Agent, Ashbel W. Walworth, Esq., from August to December 1838. Colonel T. B. W. Stockton, who was in charge of the Harbor improvements in 1845-6, caused a full meteorological and water register, to be kept from August 15th, 1845, to September, 1846. A large number of irregular readings were made by the late General

Ahaz Merchant, I. N. Pillsbury, late City Engineer, Captain B. Stanard and myself, extending from 1834 to 1859, but not at regular hours, nor on consecutive days. The labor is too great for any person to undertake who is not employed for that purpose. In addition to the observations made at Detroit, by the first Geological Survey and by A. E. Hathan, City Engineer, and Jacob Houghton as Engineer of the Water Works, there have been a large number of readings at Black Rock, and at Buffalo, New York, by the Engineers of the Erie Canal. All these can be brought together and thus made to supplement each other. On the supposition that the Lake in calm weather is *approximately level*, readings made here and at either of the other places at the *same time*, may be regarded as representing one plane surface. The Detroit gauge is higher than the others by the descent of the river from there to Lake Erie; but the fluctuations are in consonance with those in the Lake, and therefore may be used. After the water tables at Detroit, Cleveland and Buffalo were made out, it appeared that they had some periods of time in common, and thus they could be brought together as one series of observations, good for the entire Lake.

For instance, Mr. John Lothrop, an intelligent engineer in the employ of the State of New York, and myself, made observations for the month of July 1851. The average for that month at Cleveland was 1.96 feet, and at Buffalo 9.46 feet above the metre sill of the guard lock.

This gives for the Cleveland zero 11.42 feet above the Buffalo zero. At Detroit Mr. Hathan used the base of the tower of Water Works, and measured downwards from that as zero. By comparing his tables with ours and disregarding the descent of the river, I find his zero to be 3.43 feet above ours, or 14.85 above bottom of Canal at Buffalo.

In this manner, I have combined all the reliable monthly averages from 1838 to 1853, at the three ports of Buffalo, Cleveland and Detroit, into one expression in the form of curves, as shown in the engraving on the next page.


Canal depth
Jany.
Feby.
Mch.
Ap.
May
June
July
Aug.
Sep.
Oct.
Nov.
Dec.
Canal depth
13.42
Top of East Pier, Cleveland
Cleveland Zero
11 ft.
10
9
8
7
6
5
4
3
2
1 ft.
1838
1839
1840
1841
1845
1846
1850
1851
1852
1858
1819
Bottom of Erie Canal enlarged Buffalo Zero

These results and those which may follow from the Government observations are of great importance to the commercial interests of this Lake. Harbors, piers and channels to be permanent must be constructed with reference to low water. Prior to 1854 the chief of the Topographical Corps, under whose direction the surveys of the Lakes were conducted, paid no attention to these fluctuations.

One of the consequences of this oversight has been the reconstruction of the Canal at the Sault Ste. Marie. Locks that were built to pass vessels of *twelve feet* draft, would at times allow of only *nine feet.* Soundings were referred to no fixed plane. There may be a difference of *five feet,* between the early soundings on the lakes and the true depth of water. Private docks and warehouses are also affected.

The proper plane of reference is that of *mean water level.* Below this, arrangements should be made for a depression of two feet six inches for extreme low water, which may temporarily reach *three feet.*

There is another cause of depression which is having its effect continually; but is so small as to be imperceptible during the life of a generation. This is the perpetual wearing away of the channel at the outlet. On the Upper Lakes there are evidences of a perceptible lowering of the outlets, since they assumed their present general level; but on Lake Erie it is not yet perceptible. It does not probably exceed an inch in a century.

According to tradition among the French residents of Detroit, which was settled in 1701, there has not been since that time as high water as that of 1838.

A conjunction of circumstances such as to cause a state of extreme depression, or extreme high water, will occur only at long intervals, owing to the extent of country drained by the lakes. The tables show that there is no period of *seven* years, or a multiple of seven. This is a popular belief derived from Indians, by the early settlers, which has not yet entirely died away, but which never had the support of observations.

Mean *annual* fluctuation, result of sixteen years' observations	1 ft. 1½ in.
Difference of *highest* and *lowest* months within the year. Cleveland, 4 years obs.	2 " 2 "
Greatest *temporary* difference not due to visible storms. Cleveland	3 " 2 "
Greatest *permanent* difference, 1819 to 1838	5 " 3 "
Greatest *temporary* difference between 1819 and 1838	6 " 11 "

Bench marks in the city of *Cleveland*, referring to city zero, which is the line of high water of Lake Erie in June, 1838, 566.50 feet above mean tide water at Albany, N. York: *

1.	Surface of stone work, East Pier, 400 ft. from the south end (now lost)	2.00	feet	A.
2.	Capt. Meade's U. S. Top. Engineers, 1859, on a pile east of No. 1	2.92	"	"
3.	N. E. corner of base water table, Hotel corner of Main and River streets, west side. City Engineer Strong, 1874	3.129	"	"
4.	N. E. corner Myers' Stove Works, River street, west side. Asst. Engineer Wheeler, U. S. Survey, 1874	3.127	"	"
5.	Door sill, S. west corner of Engine House, C. C. & C. R. Road, Front street. I. N. Pillsbury, City Engineer, 1854	5.829	"	"
6.	Coping of west wing wall of canal lock at the Cuyahoga river. R. E. Howe, State Engineer, 1838	6.300	"	"
7.	First course of masonry, base of Light House, 3 ft. above ground, Water street; projection of 0.200 ft. over the course below. Asst. Wheeler, Lake Survey, 1874	67.713	"	"
8.	N. E. corner of base of Perry Monument. C. G. Force, Asst. City Engineer, 1874	86.533	"	"
9.	Mitre sill of guard lock, Erie canal, Buffalo State Engineer, John Lothrop, 1854	11.420	"	B.
10.	Base of water works tower, Detroit. A. E. Hathan, City Engineer, 1854	3.430	"	A.

Plane of Soundings at Cleveland:

	Stage of water		
U. States Assistant Engineer, Geo. Fell—fall of 1873	2.500	feet	B.
City Engineer, Chas. Strong, Feb. 1873	2.920	"	"
Col. T. B. W. Stockton, Harbor Agent, April, 1846	4.400	"	"
Lowest water, monthly mean, March, 1846. Stockton's daily register	4.770	"	"
Average low water at Cleveland, Detroit and Buffalo, 1846	4.620	"	"
Extreme low water—by monthly average—1846	5.100	"	"

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* Mr. Jos. T. Gardner, Geographer, Washington, D.C., has in connection with the U. S. Coast Survey revised the elevations of the Lake region and the Mississippi valley, by whom mean tide at Albany is 4.84 feet above mean tide at New York.

Elevation of the Great Lakes above the Ocean. *

It is not practicable to fix the elevation of the surfaces of these lakes, until their mean fluctuation is known. The results I propose to give, are therefore only approximate.

On Lake Superior the greatest known range of level is three feet, with indications of a much greater range. Lake Ontario has a variation of four feet, nine inches, well determined by water registers, since the year 1812.

The surveys of the Upper Lakes, by the United States Government, now in progress, will eventually fix the mean level of all the lakes, by observations which are made twice each day.

For present use, I give the mean results of instrumental surveys between tide water and the lakes, and between the different lakes.

Before doing this I must remark, that in none of them is the stage of water noted, at the date of the Survey, whether above or below the mean. There is therefore room for a plus or minus error of two or three feet, when referred to a plane, which shall be fixed upon, as the mean level of each lake. There is also another ground of error. The lakes are not strictly level but have an inclination or descent towards their outlets; though this may be small, and in part corrected by the action of winds.

To fix the elevation of the lakes, I begin at those nearest the sea, to which instrumental surveys have been made. The Upper Lakes are not thus connected by direct lines, but their height above tide is determined by reference to those below.

There is quite a discrepancy in the results, which can be accounted for as I have above stated.

LAKE ONTARIO.

By lockage in the St. Lawrence canals, above mean tide,	234½	feet.
By canal surveys of New York, above mean tide, ...	232	"
Mean elevation, ...	233¼	feet.

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* In a letter to the Editor, Col. Whittlesey states that this portion of his paper was "inserted in 1866 in a Report on a part of Minnesota," and that the estimates differ somewhat from those which have been recently made by the U. S. Coast Survey. The importance of a "revision of the descent from Lake Ontario to Quebec" is also urged. —Ed.

LAKE ERIE.

By canal surveys in New York, 1817,	561.20	feet.
By Capt. Williams report of 1834, Niagara Ship Canal,	563.00	“
By surveys Caatskill & Portland Railway, 1828,	565.33	“
By locks of New York Canal,	567.00	“
		“
Mean,	564.13	feet.

LAKE HURON.

S. W. Higgins, Geological Report of Michigan, 1838,	577	feet.
A. Murray, Geological Report of Canada, 1849,	578	“
Mean,	577½	feet.
Lake St. Clair, Geological Report Michigan,	570	“

LAKE MICHIGAN.

Southern Michigan Railway, J. H. Sargent Engineer, survey of 1856, south end	583	feet.

LAKE SUPERIOR.

By Cayt. Bayfield's barometical measurement in 1824, 627 feet, evidently too great.		
A. Murray's determination, Geological Survey of Canada, 1849, 599.41 feet, say	600	feet.
Survey of Bay D'Enoch & Marquette Rail Road, 1859,	610	“
Mean,	605	feet.

GREAT SEAM COAL REGION, OHIO.

COMPARISON OF STRATA.

BY COLONEL CHARLES WHITTLESEY.

The profile I published a short time since extending from the valley of Little Monday creek, near Maxville, through Straitsville to the valley of Snow Fork, was on the line of dip south seventy degrees east, and therefore across the stratification. It was ten (10) miles in length, exhibiting a breadth of outcrop of the beds ten miles wide, and a thickness of the strata of about 350 feet, rising from the Maxville to the Cambridge limestone. In this space there is known to be seven (7) beds of iron ore, four of coal, and in places six (6) of limestone.

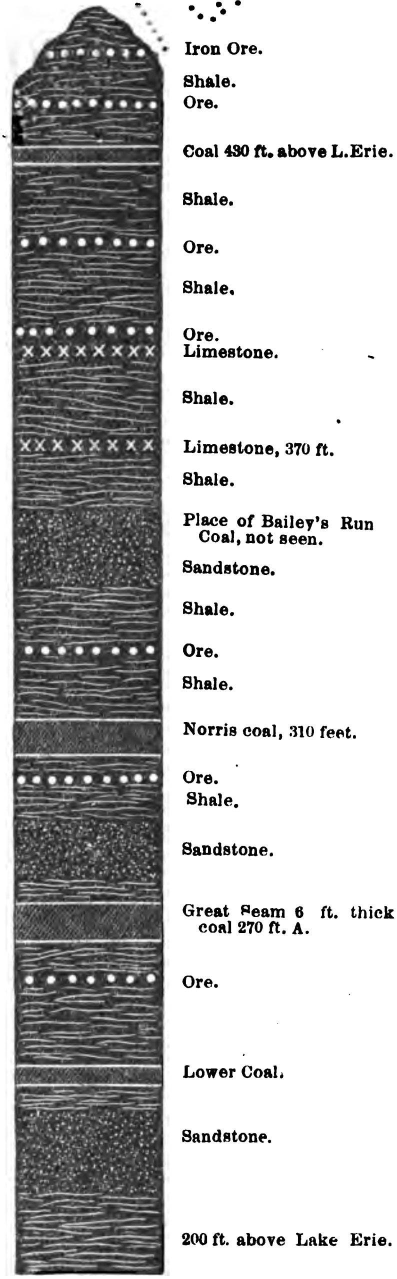
The two profiles of Mr. James Nichols, M. E., which, through the courtesy of Colonel Riley, I was enabled to examine, are made, one through Moxahala due south into the valley of Sunday creek, passing Buckingham and thence along the divide between the waters of Snow Fork and Sunday creek, in Trimble township, Athens county, to Salina, on the Hocking river, a distance of 20 miles. His other profile is at right angles to this, or east and west, extending from the valley of Sunday creek, across Snow Fork and Monday creek, to the dividing ridge between this creek and the Hocking river. It follows the line between the second and third tier of sections, from the south line of Trimble, Ward and Green townships. Both of these profiles are oblique to the *dip* and to the *bearing* of the strata. Having been made with much care, by the use of an engineer's level, they give us, for the first time in this region, an exact physical profile.

No survey of a mineral district can be considered complete until such profiles are made at intervals of a few miles apart, the direction of which should be on the line of dip, and on the line of bearing. We thus get a continuous series of local profiles from valley to valley and from hill to hill, in which at least the elevations, and therefore the inclination of the beds, are forever fixed. Without a party of men to uncover the beds, it is not possible for a mining engineer to find all the outcrops, and to assert that the strata are fully developed; but he has in this way laid the foundation for subsequent explorers to work upon, which is perpetual.

In this paper I have grouped a series of four local sections on the *line of bearing* or *strike*, which is about north 20 degrees east, but curves to the east in going north, beginning on the south near Carbon Hill, passing near Straitsville, but a little east, near Shawnee and a mile west of Moxahala, a distance of fifteen (15) miles.

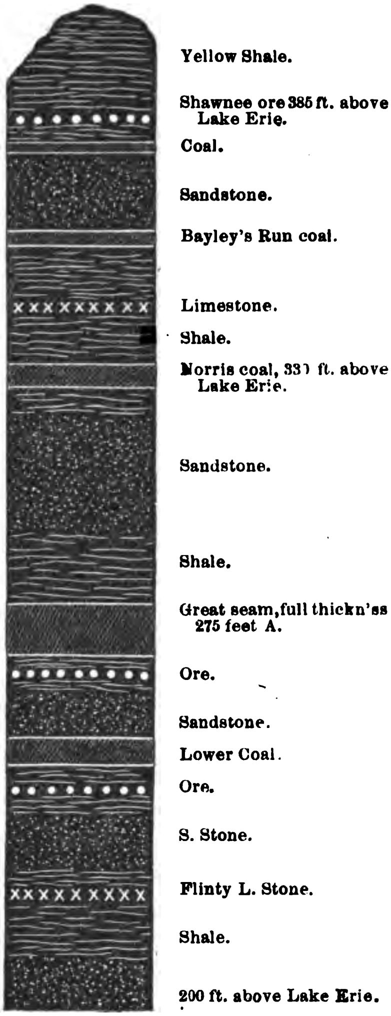
The remarkable regularity of the Great seam appears from the uniform elevation of its outcrop at the four places referred to. On the west side of the valley of Monday creek, by Mr. Nichols's profile, its elevation above Lake Erie is 270 feet, on the heads of Middle Fork, 265, 259 and 275; at Shawnee 275 to 287; between Moxahala and the Koons tunnel, 260 to 275; seven miles further in the same general direction along the strike, near McLuney's station, 260 to 275. These figures refer to the bottom of the beds, in all cases, and are as near correct as can be expected without a series of levels made for the purpose. The engineers of the railways pointing to this region, have given me every facility in procuring levels, especial-

SECTION NO. 1.—NEAR MOXAHALA.

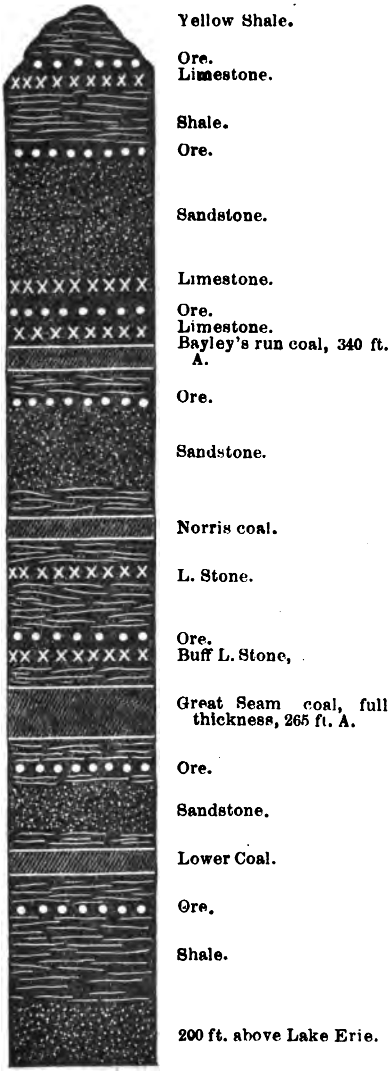


Vertical scale 40 ft. to the inch.

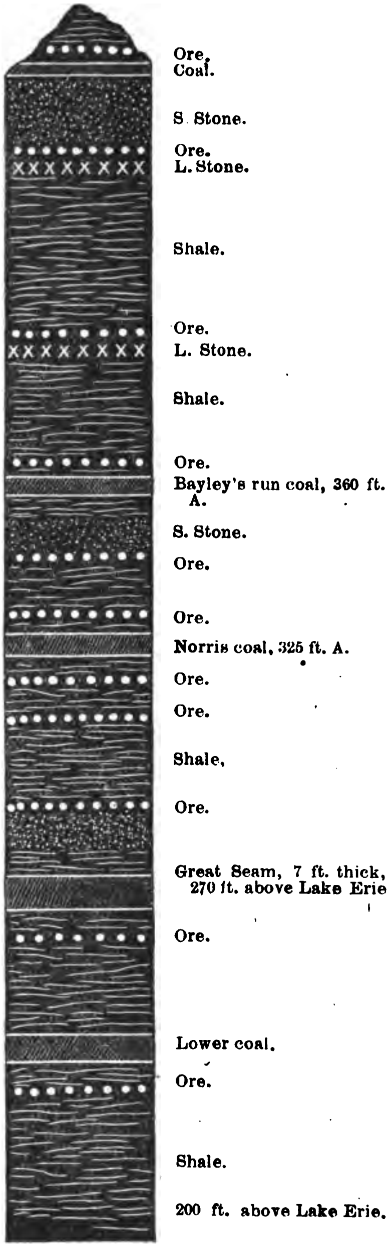
SECTION NO. 2.—NEAR SHAWNEE.



SECTION NO. 3.—NEAR STRAITSVILLE.



SECTION NO. 4.—NEAR CARBON HILL.



ly J. W. Riley, Wm. H. Jennings, Carey Wilson, George S. Lester and M. A. Mansfield. There are certain doubts and discrepancies about some of the zeros when referred to Lake Erie; but these are reduced to small limits. I will give more of the elevations further on.

This group of profiles represents the full breadth of the Great seam area, from its southerly edge, where the coal is seven feet, to its northerly, where it is six feet, passing through the maximum of ten and eleven feet. For details of thickness see Professor Andrews in Geological Report of 1869–70, pages 97 to 103.

As I have said before, this bed of coal is the only stratum that is found *everywhere in its place*. All others, whether of coal, ore or limestone, are in places wanting. It follows, therefore, that we can not count absolutely upon a continuance of these beds, though beneath every divide, from valley to valley. The two outside sections, Nos. 1 and 4, near Carbon Hill and Moxahala, are substantially those of Mr. Nichols, and are at the extremities of his two profiles. In some cases the actual observed points are somewhat one side of the direct line, because the strata are frequently concealed, where the explorer is most desirous to see them.

LEVELS SHOWING THE DESCENT OF THE GREAT SEAM ON LINES CROSSING THE STRIKE NEARLY AT RIGHT ANGLES THROUGH THE SEVERAL PROFILES.

1. *New Lexington to Moxahala.*

(Course southeasterly—distance five miles.)

Onehalf mile south of N. Lexington	360	A. L. E.
Sec. 15. Pike township, near Koons tunnel	335	"
Sec. 23, Pike township	285	"
Sec. 25, Pike township	265	"
Sec. 30, Pleasant tp., near Moxahala	255	"

2. *Bristol to Buckingham.*

(Course southeast – distance eight miles.)

Bristol tunnel	390	A. L. E.
McCunesville	345	"
Northwest quarter section 16, near Shawnee	311	"
Shawnee	275 to 287	"
Sec. 23, Salt Lick township	246	"
Buckingham	175	"
Sec. 26. Monroe township	142	"

3. *Monday Creek to Snow Fork.*

(Course southeasterly—distance nine miles.)

Sec. 24, Monday Creek township	335	A. L. E.
Sec 19, Salt Lick township	320	"
Straitsville Mining Co	287	"
Sec. 33, Middle Fork	270	"
Sec. 12, Snow Fork, Ward tp., about	206	"

4. *Haydensville to Snow Fork.*

(Course nearly east—distance eight miles.)

Sec. 1, Green township	317	A. L. E.
Sec. 32, Monday Creek, near Carbon Hill	270	"
Sec. 14, Ward tp., Poplar run	205	"
Sec. 2, Ward tp., Snow Fork	129	"

GENERAL ELEVATIONS OF THE GREAT SEAM.

McLuney's Station	263	A. L. E.
Tunnel four miles southwest, 24 feet below grade	338	"
Near New Lexington	360	"
Moxahala	255	"
Koons tunnel, three miles southeast of New Lexington	330	"
Bristol tunnel, north end	386	"
McCune's salt works	345	"
Newark Coal Co., Shawnee	287	"
Buckingham	165	"
Sunday Creek, on Athens county line.	76	"
Wright's bank, one mile west of Straitsville	335	"
County line, sec. 32, Salt Lick	284	"
Hayden's mine, sec 1, Green tp	317	"
Sec. 24, Lost run, Ward tp	265	"
Head of Michael's run, Ward tp	250	"
Heads of Poplar run, Ward tp	206	"
Sec. 19, Brooks's mine, Ward tp	213	"
Heads of Lick run, York township, Athens county	238	"
One mile below Nelsonville, Athens county	138	"
Snow Fork at county line	126	"
Sunday Creek at Ewing, Athens Co.	75	"
Salina, mouth of Sunday creek, Athens county	15	B. L. E.

For the principal part of these levels I am indebted to Mr. Jennings, Chief Engineer of the Hocking Valley railroad, and to his maps of this region.

These sections represent geological columns several miles asunder, on or near the line of bearing along which the strata theoretically are level. Looking southeasterly in the direction of the dip, the left hand column, or No. 1, gives a reasonable good exhibit of the beds near Moxahala, within a mile to the northwest. The Great seam is here the Upper New Lexington, the one next below the Lower New Lexington, and they are about the same thickness. They extend beneath the Koons tunnel three miles to the northwest, beneath the Bristol tunnel, six (6) miles to the west, through the country east of New Lexington, and beneath the tunnel three miles northeast of that place, into the valley of Jonathan's creek, where both of them are worked.

From Moxahala they extend down the valley on both sides, to its mouth near McLuney's station, and thence to Zanesville. For the two coal seams next above these, I use the names given them by Professor Andrews. The first above the Great seam is called by him the middle or "Norris" coal, and the second the "Bayley's Run" coal. There are places where one of them appears to be wanting, but probably more thorough examinations will show that they are generally present. In section No. 1, taken principally from Mr. Nichols, the Bayley's run is not seen. They have been traced from the lower part of Sunday creek valley in Trimble, up that stream and its branches, through the ridge into the valley of Moxahala; also, to the west into the valley of Snow fork, and to all the eastern branches of Monday creek. Their thickness varies from two to five feet, and the quality of the coal is not uniform, but is of the fat cementing or coking variety. Thus far the coke has not proven to be very solid, but under improved methods this difficulty can be overcome.

ELEVATIONS OF THE FIRST AND SECOND COAL SEAMS ABOVE THE GREAT SEAM.

	First Seam.			*Second Seam.*		
Locality.	Thickness. ft.	in	Elevation. ft.	Thickness. feet.		Elevation. ft
Salt Lick, Perry county, Sec 33	2	3	42	2½ to 4½		70
Salt Lick, Perry county, Sec. 33, near center	2	2	50	4	7	80
Salt Lick, Perry county, Sec. 34	4	0	34	..		..
Salt Lick, Perry county, Sec 21	5	0	50	..		..
Salt Lick, Perry county, Sec. 23	4	0	40	..		..
Salt Lick, Perry county, near Straitsville	2		50	..		..
Salt Lick, Perry county, near Shawnee	2	0	40	4	0	70
Monroe tp., Perry county, Sec. 19	4	6	52	..		90
Pleasant tp., Perry county, Sec 10	..		35	..		..
Pleasant tp., Perry county, Sec. 30	4	0	30	..		..
Bristol, Perry county	thin		50	6	0	70
Ward tp., Hocking county, Sec. 6	..		35	..		75
Ward tp., Hocking county, Sec. 3	3	6	50	..		85

SECTION NO. 2—SHAWNEE.

The usual four beds of coal are found around Shawnee in their proper places, also a fifth higher up, not yet explored, lying a little below the Iron Point ore. Two furnaces are running on the Great Seam coal, and the upper or Shawnee ore. The two upper coal seams are bituminous and coking, but are not very uniform in thickness. Coke has been made from the Norris bed, and though not satisfactory, there are no doubt modes of making it which will secure better results. The flinty limestone below the lower coal is probably local, being rather too high for the "Putnam Hill" limestone.

Passing over a low summit on the east to the waters of Sunday creek, the blue limestone and three beds of coals may be traced down the valley of Hadley's Fork to Buckingham. Iron ore has been struck in several places in this valley. In constructing this section I have had the assistance of Captain Abbott, a civil and mining engineer residing at Shawnee. It does not reach up to the general level of the country. Beds of limestone and of ore exist higher in the hills, which are not yet developed.

SECTION NO. 3.

This and the last are a little less than three miles apart. It is partly a composite intended to represent all the reliable beds now uncovered, of which there are seven (7) of ore, five (5) of limestone and the entire group of coal seams. The same seams were shown in the profile heretofore published passing through Straitsville on the line of dip. Both the Bayley's run and the Norris coal have been opened on sections 33 and 34, but nowhere extensively mined. In the five mines around Straitsville the average thickness of the Great seam is ten (10) feet. Here it is near the bottom of the valleys, but rises rapidly to the west, so that on Monday creek it is well up to the tops of the hills.

As the beds rise in this direction the group of iron ores beneath the Great seam become more and more accessible. Ore No. 2 from the top of the section, is in the place of the great Shawnee or Iron Point seam, overlaid by the same yellow and dun colored shales. The limestone which caps the hills is probably the "Cambridge" lime rock of Professor Andrews, which generally has ore on the top of it. Between the Norris and the Bayley's run coal there is a bed of ore that has been found every where in its place, though it varies in thickness. In the country it has the name of the Sour Apple seam. The beds of lime rock between the Norris and the Great seams are not persistent, but appear to be local patches.

SECTION NO. 4.

This is made up by slight changes of out-crops from the profile of Mr. Nichols. It shows eleven (11) beds of ore, none of which are as yet fully wrought. Explorations are going on, on the eastern branches of Monday creek, Lost run, Sand run, and Poplar run, which indicate that there are several workable beds. All the seams of coal are present in their proper places. The main object in composing these four sections, taken at intervals along a line of 15 miles in length, is to show the *regularity of the series.* In No. 1, at Moxahala on the extreme north, the Bayley's run coal is not shown, but it will probably be found in further research.

I have marked its place on that section.

On this section the upper limestone is regarded as the Cambridge. No beds of lime rock are yet discovered below the Bayley's run coal. None of these sections go down to the Putnam Hill limestone, which is about (80) eighty feet below Great seam, but in none of them is the limestone wanting. If the Shawnee ore is here, its place should be about one hundred feet above the Great seam, coming in above the Bayley coal.

In all of these sections, and all other sections and profiles I have seen in this region, all the materials exist for making iron on the spot, and therefore at the lowest possible cost.

FORMATION OR ORIGIN OF COAL.

This is a purely theoretical question, very interesting, but of no practical bearing. Of late years geologists are so nearly unanimous in their belief that coal is of vegetable origin, that an opposite theory is certainly against authority, and therefore regarded as a scientific heresy.

But nothing can be regarded as science, until it reaches the form of a demonstration. Discussion, hypotheses, opinions or beliefs do not constitute science.

My views on this subject are of long standing, and published as early as 1839; but during the past twenty years I have published nothing and said very little on the subject, not because my convictions are changed, but because it is wholly a speculative question.

It would require a horse and cart to carry all the disquisitions that have been published in that period to sustain the vegetable theory, and there is little prospect of a diminution. I refer to it here for the following reasons:

No sooner had the bill authorizing a geological survey of 1869 become a law, than the present director of the survey appeared in person at Columbus to solicit for his place. He held a life long professorship in New York, but coveted the survey and its emoluments in addition. The Secretary of the State Board of Agriculture likewise held a good place, but likewise wanted more. A cabal or ring was organized to accomplish these objects. How much influence they exerted upon the Executive, I cannot say; but the result was that if his prerogatives had been placed in their hands, they could not have had matters more their own way. It tallies with all precedents that places obtained by such combinations, result, as in this case, in defiance of law and neglect of duty. I have it, on credible authority, that this virtuous ring considered it honorable and proper to use my opinions on the origin of coal, to my disadvantage, in their electioneering efforts around the State House, although I have published nothing on the subject for twenty years. I did not feel inclined to continue a discussion of no practical importance, neither am I disposed to change my convictions, merely for prudential reasons, and therefore now restate the objections I hold to the vegetable theory.

They are in short that *three physical impossibilities* must be overcome before it can be received. First—It is impossible to account for the requisite accumulation of vegetable matter, upon the hypothesis of peat bogs, for peat is never produced in tropical climates, and the vegetation of the coal strata is entirely tropical. Peat belongs wholly to high temperate or to low Arctic zones. It knows no geological horizon, but is a surface deposit in restricted local patches on rocks of all ages, and not itself older than the drift era. The peat and muck beds of that era, covered by the drift, have nowhere been transformed into coal.

This mode of supplying vegetation has recently been given up, and in its place we have that of tropical air growing ferns, palms and mosses, rooted in vast marshes of shallow salt water.

Secondly—No marshes of an extent equal to even the small coal fields exist upon this planet. It is neither philosophical or scientific to assume, without proof, that they have existed because a theory requires it. The largest of known marshes are at the deltas of great rivers, such as the Ganges, the Amazon and the Mississippi. None of these produce the vegetation of the carboniferous era. In none of them has coal been formed. In none has the plant growth arranged itself in layers or strata separate from the mud by which it is covered. The vegetation itself has only a limited portion of the chemical elements found in coal. Neither lime rock, iron ore, or sandstone which form the principal part of all coal fields, are formed in the delta deposits. Vegetation exposed to the air in hot climates perishes rapidly. It does not assume the form of preserved carbon. To accumulate and preserve vegetable carbon from such a growth requires conditions and chemical changes of which we have no examples in nature. It is not impossible that solid deciduous or resinous trees may be more or less carbonized by deep burial in the earth, but the soft cellular watery tissue of tropical plants is quite a different thing.

Thirdly—If such extensive and shallow swamps existed, filled with a dense tropical vegetation, accumulated in such immense quantities, several hundred feet thick, without decay, and being entombed, were capable of furnishing the elements of coal, it is still necessary that for every stratum thus formed the land should sink regularly to such a depth that earthy sediments must form over it, and remain so for a period of great geological length. The land must then rise parallel to its first position, and having reached within a few feet the surface of the ocean, must cease to rise, and remain fixed there during another geological period. It must thus rise and descend as many times as there are layers of coal, each time with the same horizontal precision.

Before adopting an explanation surrounded by so many complications and incongruities, we should consider whether there are not modes of formation more in accordance with the simple and direct operations of nature, known to have been in operation in other rocks interstratified with coal. These are sandstone, shale, iron ore and limestone, which no one denies are sedimentary and chemical deposits from the ancient saline waters of the ocean.

It is not philosophical to take the coal beds interstratified with these rocks, out of the same category, until we are absolutely compelled to do so. The waters and the atmosphere of the carboniferous era embraced all the ingredients to form all these strata, and the only question to be solved is the *mode of separation* or segregation. These ingredients were carbon, sulphur, oxygen, phosphorous, hydrogen, silica, magnesia, alumina, iron and lime.

There is solid carbon in the form of graphite, and the carbonates of iron, magnesia and lime in the old rocks where there is no proof of vegetation, and like the coal beds immeasurably beyond the supply of all the vegetation, recent or remote, of which there is any proof. There are oxy-carbons and hydro-carbons, in formations more ancient than the coal or any known vegetation.

They had only to obey their chemical affinities to form, under known laws, all the beds of our coal series.

Cleveland, Ohio, June 1, 1877.

GEOLOGY OF PORTAGE COUNTY.

By Colonel Charles Whittlesey.

Prior to 1853 I had explored for the outcrop of Coal No. 1, from Massillon up the Tuscarawas Valley to the Summit, near Akron, thence through Coventry, Springfield, Tallmadge and Brimfield to Ravenna, and over the Summit in Edinburg, Charlestown, Paris and Palmyra, in the valley of the Mahoning. These explorations were in detail, on every farm where the rocks appeared in place. On about twenty of those farms, borings and excavations were made to ascertain the thickness of the coal. At that time shaft-mining had not been much thought of in Ohio, and even now has not been much put in practice.

A remarkable feature of Coal No. 1, along this line of fifty miles in length, where it is found in place, is that the seam is not generally of workable thickness on the outcrop. The borings that have since been made within the border of the coal-field disclose great irregularities in thickness. After passing ten to fifteen miles within the basin towards its central parts, it is quite doubtful whether No. 1 will be found: or if its geological place shall be found, whether it is of mineable thickness. What its quality may be is still more uncertain than its thickness. Persons who own land within a few miles of the outcrop, not higher than the limestone beds, No. 1 or 2, should test these questions by boring, because there are chances of success.

So little that is new or practically valuable has been disclosed by the recent geological survey, in the counties along the line I have mentioned, that I am induced to give some of my observations, made before the survey was authorized.

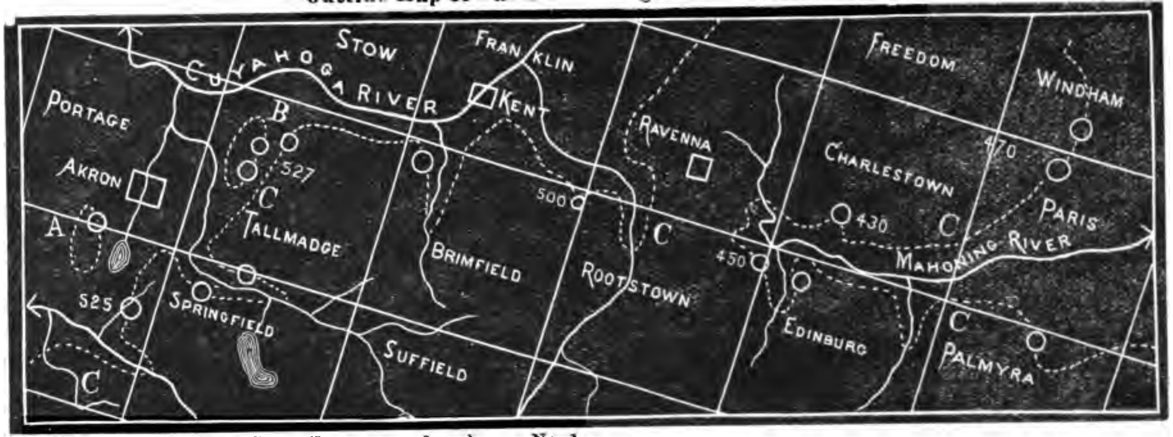
The accompanying outline map shows, by the broken line C. C. C., the general edge or outcrop of coal seam No. 1. On the Sumner Hill, west of Summit Lake, near Akron, there is an outlier of this seam, embracing several hundred acres, represented by the oval at A. The coal has been seen in several places, but nowhere exceeding three feet in thickness. Across the valley to the east in Coventry and Springfield it attains a workable thickness, over a large space, where it is and has been extensively wrought. At B., in the northwesterly part of Tallmadge, is another outlier, where the first coal in Ohio was worked in the year 1810. From this property the first coal was taken to the Ohio Canal for the Cleveland market in 1828 by my father, Asaph Whittlesey, and Samuel Newton. In 1838 the Tallmadge Coal Company was organized, embracing nearly all the hill. Under more than half of it the coal was not thick enough to be successfully worked. The remainder is now nearly worked out.

It has been found at its proper elevation through Tallmadge from the Little to the Great Cuyahoga Rivers, but at only a few points of workable thickness. Borings made on the highland in Tallmadge, east of the outcrop, have not been successful. Through the northerly part of Tallmadge its place can be traced by the underlying fire clay rock to Sawyer's Hill, in the northwestern corner of Brimfield, the coal being thin and frequently wanting. As shown on the miniature map, the elevation of the lower coal seam in Coventry and Tallmadge is about the same. There are everywhere local variations of level of twenty-five or thirty feet in the same mine. To get the precise average requires a careful survey of each mine and each neighborhood. The average of Coal Hill, Tallmadge, is about 520 feet above Lake Erie. Between the coal and the conglomerate there are beds of fire-clay and shale, with nodules of iron ore.

At Cuyahoga Falls, the bottom of the conglomerate is 350 feet A., and its surface 470, the level of the canal being 451. North of the Cuyahoga, in Stow, Summit county, the conglomerate is the surface rock, where the coal is, of course, wanting.

In the valley of Plum Creek, in Brimfield, Portage county, south of Kent, at the proper level the rocks are seldom seen in place, though on both sides the land is high enough for the coal, being over 500 feet above Lake Erie. The old openings are represented on the map by an O in the broken line, which indicates the outcrop. From Sawyer's Hill, easterly and northeasterly, through Brimfield and Franklin, until the valley of Break Neck Creek is reached, near where the old woolen mill of Woodward & Company once stood, the coal is covered by drift. Here it was opened forty years since, but was thin and had little cover. Thence, easterly, the place of the coal is about 25 feet beneath the canal summit at Ravenna, which is 501 feet A. L. E. Here nothing is seen in place except drift clay, gravel and hard pan. Coal—No. 1—reappears beyond the summit on the east, in the valley of Barrel Run, near Campbellsport, at a general elevation of 450 feet.

Outline Map of Parts of Portage and Summit Counties.



Dotted or broken line—C. C. C, outcrop of coal seam No. 1.
O. O. O. points where it is visible, and its elevation in feet above Lake Erie.
A. B. Isolated hills or outliers.

Many years since it was opened in the northwest part of Edinburg, on Barrel Run, and may easily be found at the proper elevation; but it is everywhere thin at the outcrop. Above it is the usual dark gray shale, and resting on this the "Massillon sandstone," which is the surface rock in Rootstown and the western part of Edinburg. As the base of this rock is 40 to 70 feet above coal No. 1, that seam should be found over a large part of both these townships, but as to its thickness it is not safe to predict. The so-called coal No. 2, which is occasionally found at the base of the Massillon sandstone, is sometimes mistaken for No. 1. This bed is of no practical value. To the west and northwest of Ravenna the Massillon sandstone may be seen, but the country in this direction and to the north, in Shalersville, is covered by heavy drift hills and hollows at the level of No. 1 coal. Through Edinburg and Palmyra, on the south side of the Mahoning, its place can be found in the ravines that come down from the hills into the valley. On the north side of the Mahoning it can be found occasionally as indicated by the dotted line and circles, through Charlestown and the northwesterly part of Paris, into the southwest corner of Windham. I have not seen it in those townships exceeding twenty inches in thickness. There are probably limited patches of coal thick enough to work under the highlands in Freedom and Shalersville, a question to be settled only by borings. Its place is about 150 feet beneath the lower limestone. The summit in Freedom is reported to be 613 feet A. L. E., which is not far from the elevation of this limerock.

On the south of Ravenna the railroad summit in Rootstown is 595, and the place of the coal less than 150 feet beneath it, probably within 125 feet. Coal No. 3 (of the reports) lies directly under limestone No. 1, or the *blue*, and Coal No. 4 beneath limestone No. 2, known as the *gray*. These limestones are seldom more than thirty feet apart, and useful guides to the position of the lower coal, but the coal strata of which they form the roof are only of local value. They are above the Massillon sandstone, and are frequently seen in the townships of Deerfield and Atwater. In boring for the lower coal, it is much better to start on a rock in place whose geological horizon is known. The probable depth can thus be known, and when that is reached, great care should be used to pump frequently and to preserve the material brought up. Without skill and close observations the value of a bore may be lost entirely.

In Suffield and Randolph the stratified rocks are generally hidden by the drift which assumes the form of true glacial moraines. There are in Suffield loose blocks of limerock that appear to be different from Nos. 1 or 2, probably limestone No. 3, or the *white limestone*, which is nearly as regular as those below, and which is not far below No. 5 Coal. It is very common in Columbiana, Stark and Tuscarawas counties, and makes a much whiter lime than the other limestone beds.

[From the Proceedings of the American Association for the Advancement of Science, Vol. xxvii, St. Louis Meeting, August, 1878.]

ANCIENT GLACIAL ACTION, KELLY'S ISLAND, LAKE ERIE.

By CHAS. WHITTLESEY, of Cleveland, Ohio.

IN September, 1873, I visited Kelly's Island in Lake Erie, for the purpose of examining the great ice grooves for which it is remarkable, especially those at the quarries on the north side.

Kelly's Island is one of a group situated near the west end of the lake in shallow water, all of them of *limestone*, in nearly horizontal beds. None rise many feet above the water level.

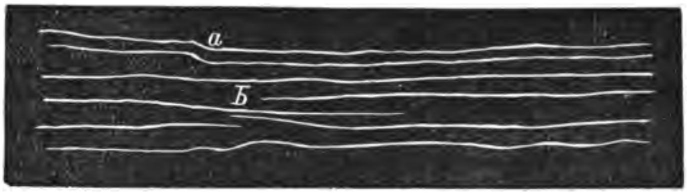
They formed originally a part of the mainland on the south, and of the low coast to the west. Probably all of the lake, west of Point Pellee, in the pre-glacial period, was more land than water. Instead of a lake with islands, it must have been country with lakes, rivers and swamps.

Wherever the rocks are laid bare, the evidences of ice action are universal and very marked. In Sandusky city many of the cellar bottoms show polished, grooved and striated surfaces of rock.

Around the islands, and along the shore, wherever the waves have carried away the drift hard pan covering the rocks, large spaces are laid bare, and the grooves and striæ are seen, as fresh as those beneath the present glaciers of the Alps.

A very convenient place to observe them is at the southeast corner of Kelly's Island, about a mile east of the *Island House.* Here the rock is very smooth and level, and the lines are remarkably straight. A sample of this glaciation embracing a length of 300 feet is here given.

Fig. 1.



Glacial lines, southeast corner of the Island, space represented 300 feet in length—general bearing S. 75° west—intermediate fine lines not shown.

The bearing of the straightest and best defined lines is S. 75° west, with slighter ones crossing these at N. 80° west, magnetic. There were a few straight grooves observed, bearing N. 25° west. These lines show a slow direct motion to the west, with short changes of direction, sometimes quite sudden, after which the original course was resumed, as at *a*, Fig. 1. In size they are from a mere line to a depth of an inch, with a variable breadth seldom greater than twice the depth. Such furrows are no doubt due to stones held firmly in the ice as it progressed. At *b*, a new groove commenced and another terminated. These stones are abundant in the hard pan, showing flat and striated facets, where they came in contact with the rock. Smaller lines and polished surfaces are due to the joint action of gravel, sand and ice.

This long-continued movement of many centuries' duration, along the axis of the lake from a northeasterly direction, cut away new channels between the islands, and ground down their surfaces. On their easterly sides the polished surfaces extend beneath the water. As the mainland rises from the coast towards the interior, they are found at all elevations, to 700 and 800 feet above the lake. The thickness of the ice mass, must have been at least 1500 feet. This slow but resistless motion, crushed and transported the soft shales of the lake basin, and materially wore away the harder sandstone and limestone strata, south and west of the lake.

By this means the face of the country was rendered less rugged than it had been in the pre-glacial period. The summits were rounded, and the valleys filled with the debris.

Across the north side of Kelly's Island is a limestone ridge, which came near being separated from the southerly part and left in the form of a long rocky islet.

The ice movement passed over it lengthwise, striking it at the northeast end, where the dock and quarries of the Calkins Lime Company now are. This projecting buttress was scarred, crushed, pulverized, and partially torn away.

The evidences of this are still distinct wherever the rock is laid bare. South of the ridge is a long depression parallel with it, which is largely due to the erosive power of the all-pervading glacier. It is now a rich valley in the form of a bay, but little above lake level, covered with vineyards. The island embraces less than 3000 acres of surface, of which this is the most valuable part for agricultural purposes.

On the sloping sides of the ridge, the rock is polished and grooved in the same manner as on the flat surfaces. Long troughs, straight, crooked and warped, are thus scalloped out, many feet wide and deep, extending hundreds of feet in length.

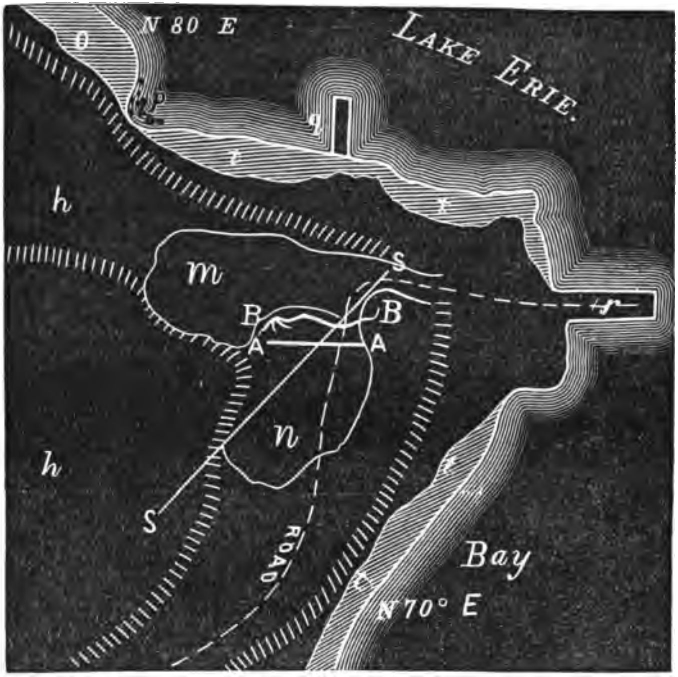
The results of this action around Quarry Point, I propose to illustrate with some detail.

Mr. John Dean, the company's agent at the quarry, has taken an interest in the bold ice lines, exposed as the work of quarrying progressed. By his care, with the advice of company, he preserved the most remarkable of them for a considerable period.

Everything was thus in fine condition for examination. It was also arranged that photographs should be taken at several points.

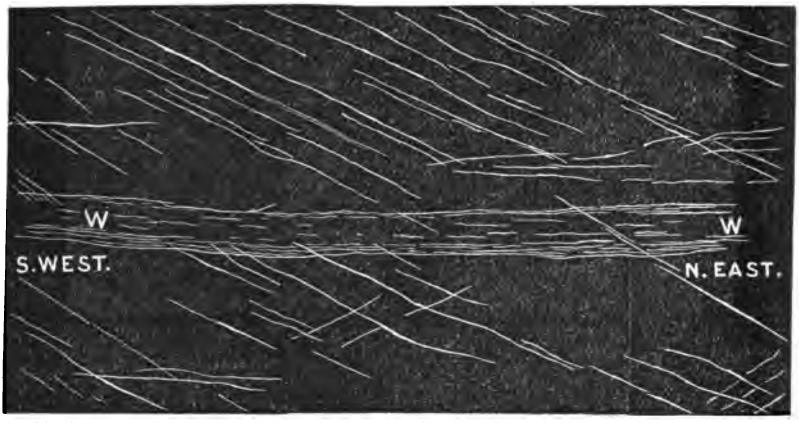
This was afterwards done with good taste and judgment, by *Mr. A. C. Platt*, an artist of Sandusky. A coup d'œil sketch of the shore and quarry is here given.

Fig. 2.



Plan of Quarry and Landing—scale 10 rods to the inch. *m*, quarry of 1873; *n*, old quarry; *r*, present dock and landing; *q*, Kelly's old dock, destroyed; *A*, large groove, straight; *B*, northerly groove, crooked; *p*, the angular stones of the old dock became pebbles by attrition; *t*, *t*, *t*, bare glaciated surface passing beneath the drift *h*; *o*, point where the tracing Fig. 3 was taken.

Fig. 3.

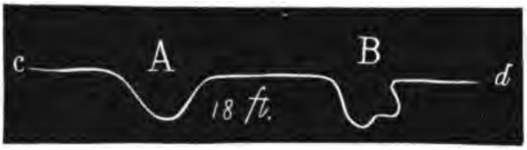


Glacial striæ at *o*, west of Kelly's dock *q*, bearing N. 80° west. The broad groove *W W*, N. 45° east. Scale one twenty-fourth of nature. Reduced photograph of a tracing on cloth.

A few views and profiles are given to represent phenomena which are so rare in the history of glaciation that I have never seen another instance precisely like them. The cut (Fig. 3), representing the striæ on a large flat surface at *o*, is from a tracing upon muslin, taken by Mr. Dean and myself, size of nature, six feet by eleven, and photographed to one twenty-fourth of nature.

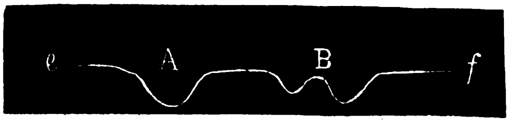
Profiles of the two largest and most singular grooves, *A* and *B*, of the coup d'œil sketch, are given in Figs. 4 and 5, much enlarged.

Fig. 4.



Profile on *c d*, Fig. 6, looking west. *A*, southerly groove; *B*, northerly groove.

Fig. 5.



Profile on *e f*, Fig. 6, looking west.

There is nothing unusual about the most southerly one *A A*, except its size. It is straight, broad and deep, and its axis is nearly east and west, parallel with the general course of the finer lines engraved everywhere on these rocks.

More interest attaches to the northerly one, *B B*. It is very tortuous and irregular, both in width and depth; and it is, therefore, quite difficult to convey a correct idea of its appearance.

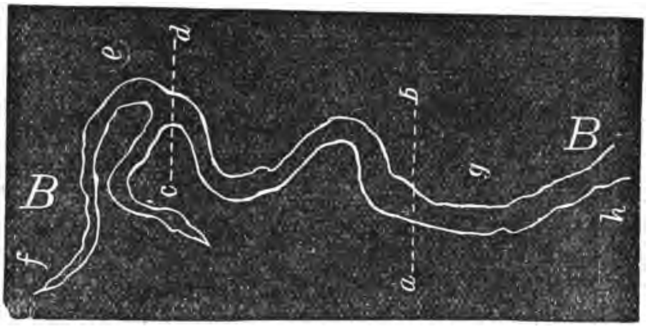
The outlines of the horizontal plan, Fig. 6, represent the outer edges, where it is broadest. Mr. Platt's photograph, which is reproduced in Fig. 7, gives a lifelike view of the upper or west end, where it is descending rapidly towards the east.

On the hardest and least perishable part of the rock within the groove, there are very fine but distinct striæ, like those on the flat rocks adjacent, plainly showing ice action; but large portions of it are smooth, indicating that a part of the wearing process was due to water action. About sixty feet in length has been uncovered, of which something more than twenty feet was destroyed in working the old quarry. It can be traced across this excavation easterly, to a knob which is left standing a few feet high, where it is covered by drift. On the west, the prongs as they become smaller, are also filled up with loose drift materials *h h*. There are parts of it near the middle which are lower than either end, but there may have been in the old quarry other branches towards the east, which were lower and have been destroyed. One of these probably came out on the bay, near the most southerly part of the dock.

For the purpose of showing the changes of form which this crooked and fluted groove exhibits, I give the Figs. 4 and 5, cross-sections.

Fig. 5 is the first one on the east, and represents the wall *S S*, about twenty feet high, which bounds the old quarry *n* on the northwest. Here the trough *B* is broad and regular, but deeper than *A*. Three strata are visible: a thin flint bed; next above it the quicklime bed, which is the most valuable; and above this to the surface, a stratum that does not make lime, but is shipped to the iron furnaces for flux. Beneath, the rock is not worked. Over the whole was originally a thin layer of drift hard pan, *h h*. In this profile the crooked groove *B B*, has been worn down into the quicklime bed.

Fig. 6.



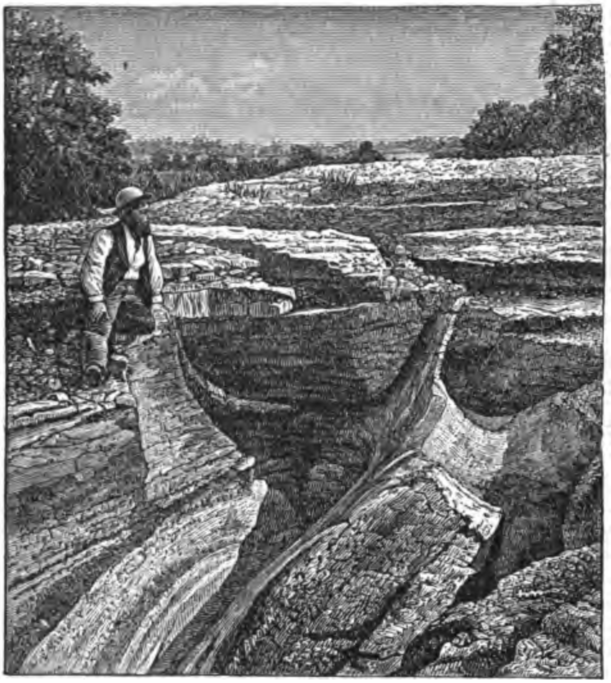
Plan of crooked groove, *B B*. Length, over 120 feet; breadth, 6 to 12 feet; depth, 4 to 6 feet; descent, *f* to *g*, 10 feet.

Profile Fig. 4, along the line *c d*, shows quite an irregular section, the north wall being vertical or projecting over the channel, the bottom of which is double and in the form of offsets or benches.

Fig. 5 shows how it is separated into branches, a view of which is seen in the photograph (Fig. 7) taken from near the point *e* (Fig. 6), looking southwest. Here the ends of all the channels, which converge at *e*, are closed with drift *h h*, and cannot be followed to the extremities.

From inspection it is evident that the sinuous groove *B B*, is due in part to the dissolving action of running water flowing out beneath an ice-cover. This flow is known to take place beneath all glaciers. It is muddy or gritty, according to the rock over which the movement takes place; sometimes carrying out gravel and small stones. The erosive effect of such streams is increased by pressure into the channel; the ice not being entirely rigid, but capable of being bent, to fit the depressions beneath it.

Fig. 7.



Upper End of Ice Groove *B*, Kelley's Island, looking Southwest.

[Printed at the SALEM PRESS, March, 1879.]

GENERAL GEOLOGY OF THE COUNTIES OF COLUMBIANA, STARK, AND TUSCARAWAS.

BY COL. CHAS. WHITTLESEY.

STRATA BELOW THE COAL.

Until it is definitely settled what is Portage and Chemung in Pennsylvania, to the Ohio line, those terms cannot be used with much certainty in this State.

The paleontologists have lowered the line of the carboniferous here, until it lies below both of them.

Stratigraphically, the following arrangement seems to me the nearest approach to a solution :

First.—Beneath the coal a "*conglomerate group*," embracing the pebbly sand rock, the shales, and the Berea grit, which frequently has pebbles of quartz. Going southerly these graduate into the Logan of Professor Andrews, and include the Maxville limestone, all of which are irregular, but belong to the sub-carboniferous series.

Second.—The "*Waverly Group*," embracing the flags and shales below the Berea grit, to the black or Huron shale. This is characterized by sandstone layers of a finer grain; a greenish-yellow color, and occasional pebbles, rapidly passing into olive or light-green shales, with thin plates of iron ore and ferruginous sandstone. The local subdivisions of these two groups, from the Lake to the Ohio River, yet remain to be worked up.

We must keep constantly in mind the distinction between the general dip of the strata and their local irregularities.

Locally they all present curved and warped surfaces; producing basins, troughs, mounds, and ridges, of no regular pattern.

Taking the lowest places in these basins, representing the sumps and swamps of the mines, over large spaces; the elevations of such points show an inclination quite regular as to direction, but differing materially as to the amount or rate of inclination. Whenever we fix the elevation of three such points, we have a plane of dip for the space represented. Until this is done, there is ample room for mistakes in the identification of strata. Any survey where these data are neglected will soon require rectification. It is much easier to arrange them conjecturally, but quite unsafe. It would be reasonable to conclude that the upheavals of the Alleghany mountain chains, which occurred after the carboniferous epoch, would produce undulations, folds, or disturbances in the Ohio coal strata, but a close examination does not sustain such an hypothesis. The irregularities visible in these beds appear to be due to currents of deposition, which swept about in channels and eddies, producing ridges and hollows on the ancient bottom, as the ocean waters do now.

Beds of sandstone and shale are the most irregular of the series. Those of limestone, iron ore, and coal, are more persistent, because their deposit is due not only to mechanical sediments, but to chemical attraction and segregation. The shales and the sandstones are almost without chemical affinities, and were deposited by currents, with a variable force, acting without system. The mineral substances with which the carboniferous seas were charged, sank in comparatively quiet and muddy waters, and therefore with more regularity than the earthy matters; but in neither case with perfect uniformity. Theoretically the thin mineral strata should be, and in fact are, about equally persistent; but it is not safe to assume that any of them are identical with other beds of the same minerological character, until the connection is made out by close examination in the field.

We have now all the facts we are likely to have for many years to come, relating to the physical geology of Ohio. Whoever looks through the reports on economical geology, in the coal-producing counties of the north-eastern district, will be unable to reach satisfactory conclusions.

A comparison of the profiles and of the text, where it relates to stratigraphy, will show numerous contradictions.

For the purpose of testing the theory of the persistence of *Coal Seam No.* 6, and of the *Putnam Hill limestone*, I have made a comparison of the vertical sections over a large part of the region. I give, in the form of skeleton profiles, the results of this comparison. To do this fairly, I assume, with the reports, that No. 6 is persistent, and use it as an horizon, bringing the other coal and limestone beds into their physical relations on that theory.

I think this comparison, thoroughly carried out, would show that No. 6 and the Putnam Hill limestone cannot both be persistent. If one is, the other is not.

After studying this subject since 1837, doing, I believe, as much field work as any other geologist has bestowed upon it, I am not able to say that any one of the coal seams of the lower series is continuous. At least it has not been demonstrated to be so, by exact physical profiles. Between the typical No. 6 coal, in the valley of the Tuscarawas and that of the valley of Little Beaver, facts are lacking to demonstrate their identity.

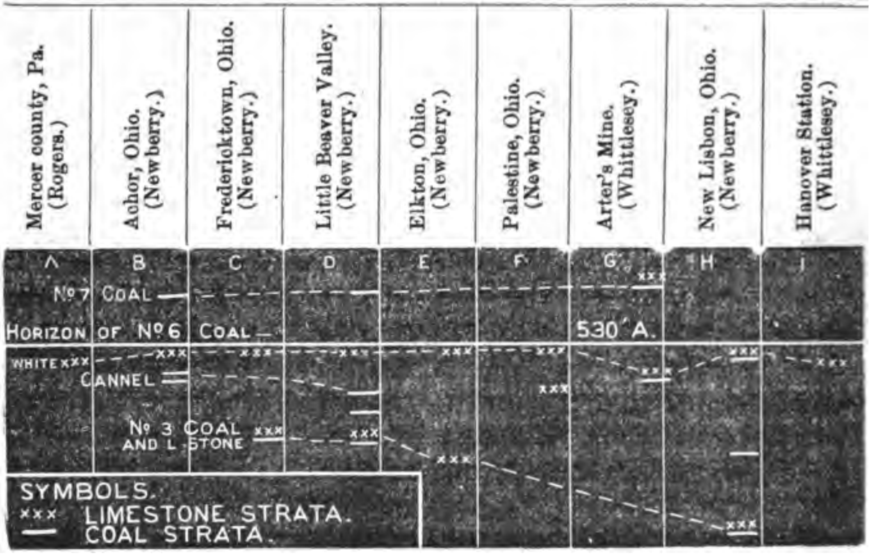
The Yellow Creek series is connected with these two valleys, as yet, only by a plausible hypothesis. From Zoar down the Tuscarawas to Coshocton, at the confluence of that stream with the Walhonding, forming the Muskingum, Nos. 5 and 6 are in place, though in several places the elevation is fifty to sixty feet too low. From the southerly part of Coshocton county to the middle of Muskingum and Licking, the connection of No 6. with the upper New Lexington seam is yet to be proven.

To make these comparisons I am obliged to use a very small scale of profile, and to be content with only a few sections. A large part of them are taken from the official reports. Groups Nos. 1, 2, and 3 follow in regular order, from the State line, through Columbiana, Stark, Carroll, and Tuscarawas counties, to Muskingum. If put together, end to end, they would form a profile of the beds of limestone and coal, for the lower coal series, half way across the State.

Figure No. 1 shows, everywhere in Columbiana county, No. 3 limestone not far below No. 6 coal.

Figure No. 2, sections *a* and *b*, in Carroll county, show No. 5 coal to have a limestone roof, which, possibly, represents the white lime-rock of Columbiana. The other official sections, *c*, *d*, *e*, *f*, *h*, *i*, do not show it. Between the Zoar section, *Figure No.* 2, *f*, which is typical for No. 6 coal, and the Zanesville section, *Figure No.* 3, *g*, typical for the "Putnam Hill limestone," there is represented a space of about fifty miles, in a direct line. The local sections of the reports for this space show, in places, two, three, and four beds of limestone beneath Nos. 5 and 6 coal. Probably a thorough exploration would bring out three seams over most of this space. Beginning at Navarre, in Stark county, Nos. 1, 2, and 3 are found in regular order, on both sides of the river; also at the forks of Sugar Creek, and thence, wherever the valleys are deep enough for them, over the summit, southerly, towards Coshocton, full half way to Zanesville.

I insert below a tabulated list of elevations at points where the three beds of lime-rock are found in the same hill.



Mercer county, Pa. (Rogers.)
Achor, Ohio. (Newberry.)
Fredericktown, Ohio. (Newberry.)
Little Beaver Valley. (Newberry.)
Elkton, Ohio. (Newberry.)
Palestine, Ohio. (Newberry.)
Arter's Mine. (Whittlesey.)
New Lisbon, Ohio. (Newberry.)
Hanover Station. (Whittlesey.)
A
B
C
D
E
F
G
H
I
Nº 7 COAL
HORIZON OF Nº 6 COAL
530′A.
WHITE xxx
CANNEL
Nº 3 COAL
AND L. STONE
SYMBOLS.
xxx LIMESTONE STRATA.
— COAL STRATA.

FIGURE 1.—GROUPED SECTIONS, COLUMBIANA COUNTY, OHIO.

(Vertical scale ¼ inch to 100 feet; 530′A. elevation above Lake Erie.)

FIGURE 2.—GROUPED SECTIONS, STARK, CARROLL, AND TUSCARAWAS COUNTIES.
(Scale and symbols same as in No. 1.)

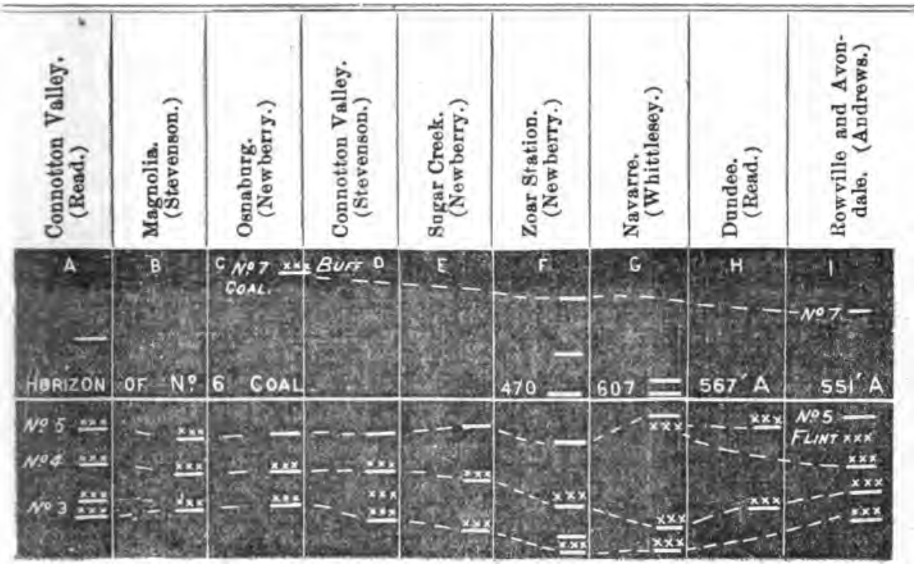
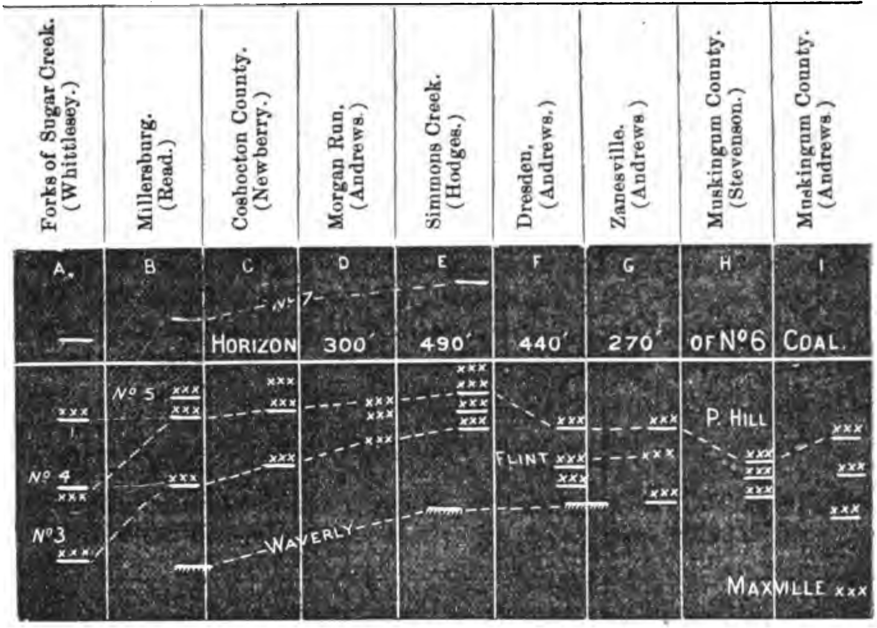


FIGURE 3.—GROUPED SECTIONS, TUSCARAWAS, COSHOCTON, AND MUSKINGUM.

(Scale and symbols same as in No. 1.)


Forks of Sugar Creek. (Whittlesey.)
Millersburg. (Read.)
Coshocton County. (Newberry.)
Morgan Run. (Andrews.)
Simmons Creek. (Hodges.)
Dresden. (Andrews.)
Zanesville. (Andrews.)
Muskingum County. (Stevenson.)
Muskingum County. (Andrews.)
A
B
C
D
E
F
G
H
I
No 7
HORIZON 300' 490' 440' 270' OF No 6 COAL.
No 5
P. HILL
No 4
No 3
FLINT
WAVERLY
MAXVILLE

This upper bed, or No. 3, not having entered into the official observations, the prmeises being false, the conclusions must of necessity be wrong. The question arises, to which of the three beds on Sugar Creek shall the typical Putnam Hill limestone be attached? Is it the equivalent of any of them? The connections I have made, by dotted lines in Figure No. 3, are not to be regarded as conclusive; they are simply official. It is much more probable that it should be connected with No. 3 limestone.

No. 2, or the "gray limestone," cannot be forced into the position of the Putnam Hill in the present state of information.

If the gray limestone of Tuscarawas could be shown to be the same as Prof. Andrews' typical Putnam Hill, this chasm would be bridged over. As yet only a few of the timbers are set up, and at points not in close relation to each other.

The Upper New Lexington seam, at Zanesville, assumed to be No. 6, is continuous to the Hocking Valley at Nelsonville, where it passes beneath the highlands that continue to the Ohio River. In this space, the number and the equivalency of the beds has been a subject of much discussion. As Prof. Andrews has devoted more time to this field than any other geologist, and his local sections are more numerous than all others, it is reasonable that we give most weight to his opinions.

By reference to Figure No. 4, the position of the three limestones will be understood, over a space of forty miles. All of the regular beds have coal under them, which is not represented on account of the small scale I am obliged to adopt. All of them have bunches and layers of flint, which sometimes extend to the entire thickness of the stratum. As groups, the three limestones and the three coals above them, Nos. 5, 6, and 7, are quite regular. Coals over limestones, so far as I have observed, have shale beneath, never resting upon the lime-rock, while coal seams underneath the lime-rock are without this intervening shale—the limestone forming the roof.

For the Sugar Creek Valley, the following arrangement fits better with the official nomenclature, than any other which I can devise on present information:

FIRST—COAL.

At the base of the series, Coal No. 1, beneath the shale underlying the "Massillon sandstone." Immediately beneath this sand rock is an irregular show of coal, of no practical value, known as No. 2.

SECOND—LIMESTONE AND COAL.

Limestone, No. 1, forming the roof of Coal No. 3; the coal often wanting and seldom workable. This limestone is frequently overlaid by iron ore. The place of Coal No. 1 is about one hundred and sixty feet below this limestone.

THIRD—SANDSTONE.

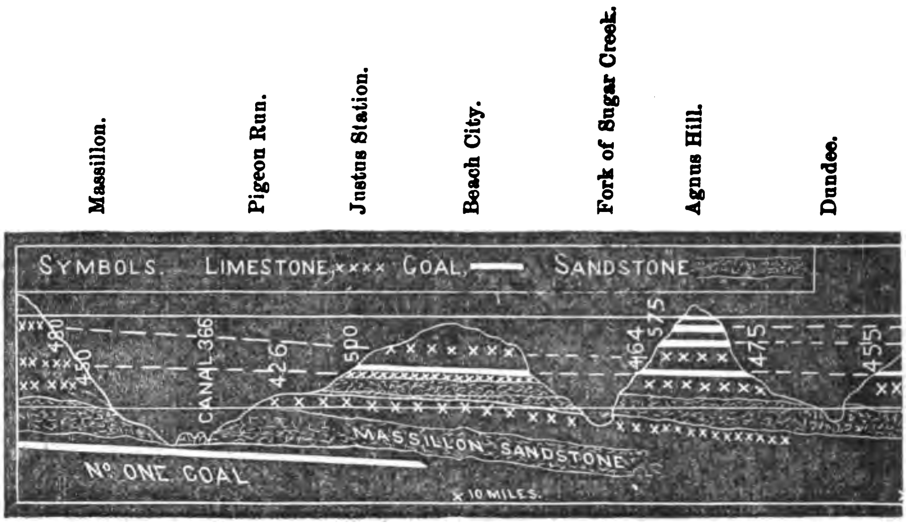
The second, or "Deardorff Sandstone," is very irregular in thickness. Beneath it there is occasionally a bed of thin irregular coal, sometimes called No 3*a*, and also No. 4. It may be seen at Sheplar's, at Zoar Station, and at the forks of Sugar Creek. Between it and the Massillon Sandstone there is a black or dark colored shale of considerable thickness. In the published profiles, this sandstone is confounded with the Massillon, the top of which is forty to fifty feet below.

FOURTH—LIMESTONE AND COAL.

Limestone No. 2, over Coal No. 4, which is probably not "Putnam Hill." In places there are both coal and fire-clay beneath this limestone. Between Limestone Nos. 2 and 3 there is another bed of sandstone, thirty to eighty feet thick.

FIGURE No. 4.—OUTLINE PROFILE FROM MASSILLON,

[Distance, 40 miles. Scale, horizontal, 440 miles to an inch



FIFTH—COAL.

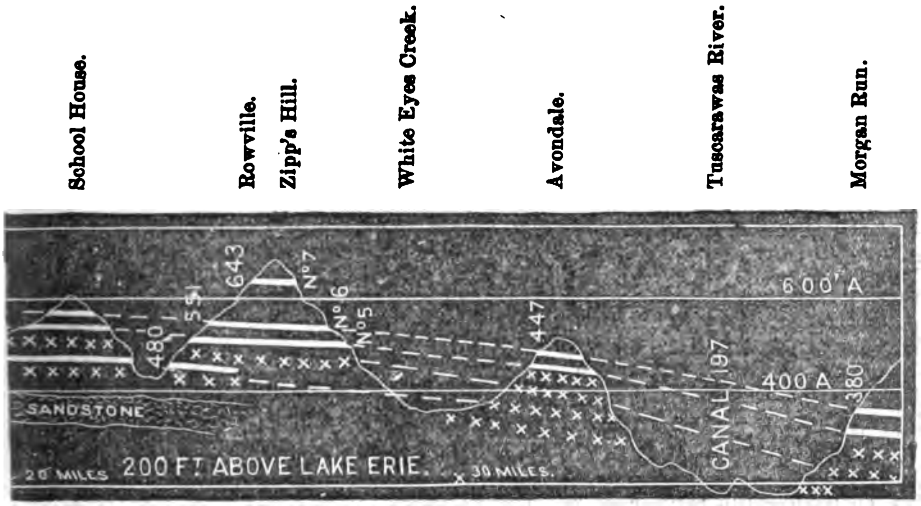
A bed of coal, three to four feet thick, ten to thirty feet above the last named stratum of limestone, which is of good quality for general uses, is opened at Fisher's mine, near Justus Station, five hundred feet above Lake Erie, also, near Bolivar, and at Weimars, 488′ A, Agnus Hill, 476′, Dundee, Barr's Mill, and around Shanesville, near which it passes beneath drainage.

SIXTH—LIMESTONE AND COAL.

Within a vertical interval of seventy-five to ninety feet, Limestone No. 3 comes in, over which in some places is a heavy sand-rock, in others a heavy bed of shale.

This corresponds to the white lime-rock of Columbiana county, and resembles the Putnam Hill, in being the first beneath Coal Nos. 5 and 6. It does not everywhere carry coal beneath it, but as it does in some places, and also fire-clay, in accordance with the Ohio system it should have a place among the numbers. At Avondale, all three of the limestones and their underlying coals are seen, according to Prof. Andrews, in regular order, but compressed into a vertical space of only sixty-eight feet. There is, besides, a bed of flint next below Coal No. 5, and, below all, a sandstone.

Through Sugar Creek Valley, to Coshocton.
vertical, 400 feet. Elevation in figures.]



SEVENTH—COAL NO. 5.

Generally, within thirty feet of the third limestone, there is a bed of coal corresponding to No. 5 of the reports. It is not everywhere workable; but, within a few feet above it, there is frequently a show of iron ore, often in great force. A heavy bed of dark brownish red shales occupies most of the space from No. 3 Limestone to No. 6 Coal, well charged with ores of iron. This bed is above the Limestone Group. It is an error to place this seam beneath the No. 3 Limestone.

EIGHTH—COAL NO. 6.

Twenty to thirty feet above No. 5 is the most regular and valuable coal of the series in northern Ohio. It ranges from 3½ to 4½ feet in thickness. Generally, after passing a light bed of shale, there is over it a heavy stratum, of irregular thickness, known as the "Mahoning" sandstone.

NINTH—COAL NO. 7.

From ninety to one hundred feet above Coal No. 6, No. 7 comes in, capping the hills, above which is the well-known horizon of *blackband* and *mountain ore.* The coal is of very little value, except for calcining the ore which overlies it. Above it there is, in some places, a lime-rock, having a blue, buff or white color, but it is not as regular as the lime-rocks lower in the series. The area of this coal is comparatively small. At Sander's Mine, west of the Kilbuck, and at Trenton, on the Tuscarawas, may be seen a blue lime rock between Coal Nos. 6 and 7, which is probably local.

The sections at Zoar, Mineral Point, the tunnel, on the Pittsburgh Branch Railroad, and near Magnolia, are quite diverse, and, therefore, not reliable, as representing a type of the series. The one made with an engineer's level by Mr. Jones and myself, near Navarre, comes much nearer to a typical section.

Since Profile No. 4 was engraved, the railway company has taken additional side levels to the beds of limestone, iron ore, and coal in Sugar Creek Valley. These have disclosed more of the irregularities in the surface and the thickness of the Deardorf sandstone. At Wm. Adams's a mile and a half north of Dundee, its surface is 460′ A., with a thickness of about fifty feet. At Graber's old mill, one and one-half miles northwest, it rises to 488′ A., with a thickness of about one hundred and eight feet. Four miles southerly, at Barr's Mill, it has sunk to four hundred feet, thickness not seen, and at School-house No. 7, three miles further south, rises to 462′.

The middle limestone conforms in part to these depressions, and in places is cut out by the elevations. At Adams's, it is 472′; at Barr's Mill, 413′; and at Shanesville, 454′. The Fisher Coal does not conform as closely to the sandstone as the lime rock. At Adams's it is about 484′, at Barr's Mill about 463′, and at Shanesville 458′.

Across the valley, east from Shanesville, on the land of Ben Hochstetler, about twenty-five feet above the Upper Limestone, a fourth lime-rock exists, which extends southerly to within a mile of Rowville, but was not seen on the west side of the valley, and is doubtless local. In places it is eight feet thick, and produces the whitest lime I have seen in the coal series. It is loosely bedded, coming out in thin, rough slabs, of a gray color. Two miles south of the Rowville Summit, I saw a lime-rock about twenty-five feet above Coal No. 6, corresponding to what I have noticed above this seam at Sander's mine, west of the Kilbuck, and at Trenton, on the Tuscarawas, of which I find no mention in the reports. On the west side of Sugar Creek Valley, there is a very great change in the sandstone beds, both above and below Coal Nos. 5 and 6.

These upper coal seams and their shales are the most uniform strata of this region. On the eastern side of the valley, the so-called Mahoning sandstone is slaty, and seldom visible, and in its place are heavy beds of shale.

The typical Putnam Hill Limestone is at Putnam, opposite Zanesville, eighty feet below the Upper New Lexington, Great Seam, or Nelsonville Coal, as it is variously called. Here this lime-rock lies about eighty feet above the channel of the Muskingum River, and one hundred and ninety feet above Lake Erie. Prof. Andrews has traced it northerly up the valley to a point eight miles north of Dresden. The detailed sections made by himself and Mr. Jones at Morgan Run, near Coshocton, do not fix the places of the Putnam Hill Lime-rock, with certainty; nor of the so-called Coal No. 6. Those made by Prof. Newberry in the valley of Simmons's Creek, eight miles west of Coshocton, do not determine its position there, nor do those of Prof. Stevenson and Prof. Read in the valley of the Licking. More physical sections and closer comparisons are necessary to demonstrate the position of the Putnam Hill Limestone in Coshocton county. For the purposes of this paper, I assume that No. 3 Limestone of the Avondale Profiles, made with strict accuracy by Prof. Andrews and Mr. H. D. Dennis, is the Putnam Hill, 384 A. L. E.

As all the profiles show a different number of seams of coal and beds of limestone in different parts of the Ohio Coal Field, it follows, of necessity, that a part of them disappear, or that additional ones come in,

The following abstract proves conclusively that all the beds can not be persistent:

ENUMERATION OF COAL SEAMS AND BEDS OF LIMESTONE IN VARIOUS PARTS OF THE COAL FIELD OF NORTHERN OHIO, REFERRED TO SEAM No 6.

Locality.	Number of coal seams.			Number of limestone beds.			Vertical space, No. 1 to No. 6, coal seams.	Thickness of lower barren measures.	Remarks.
	Below No. 6.	Above No. 6 to barren measures.	Total.	Below No. 6.	Above No. 6 to barren measures.	Total.			
Mercer and Beaver counties, Western Penn..	12	1	14	3	1	4	600	370	Rogers' Final Report.
Columbiana and Mahoning counties, on the Pennsylvania line	7	2	10	4	2	6	520	....	Ohio Reports.
Line of C. & P. Railroad, Ravenna to New Chambersburg, Ohio..........................	4	....	....	3	......	......	720 (W.)	....	
Massillon, Stark county, to Zoar, Tuscarawas county	6	2	9	2	......	......	374 (N.) 310 (W.)	....	
Yellow Creek, Jefferson county	5 (N.)	2 (N.) 5 (W.)	8 (N.)	2	5	7	310 No. 2 to No. 6 (N.)	500	
Valley of Kilbuck, Holmes county	7	2	10	2	2	4	323 (N.)	....	Beds not the same on different sides of the valley.
Valley of Black Creek, Holmes county	4	....	....	2	2	4	250	....	
Fredericksburg, Wayne county	2	....	....	1	......	......	373	....	
Simmons's Creek, Coshocton county	4	....	....	2	......	......	200	....	
Muskingum county	4	9	14	2	2	......	211	140	Prof. E. B. Andrews.

In the proceedings of the *Boston Natural History Society* for Novembe 1874, I gave reasons why No. 6 coal in the Coshocton county profiles, ma not be the seam having the same number in the Tuscarawas profile The final report places their identity in a better light than before, bu does not fully settle the question. They can not be brought into ha mony upon the theory of undulations, caused by the uplifts of the Alleghanies, for the axes of the undulations lie at all angles with these uplifts, showing that they are merely local troughs, and basins of deposition. Frequently, the lower coal seams were deposited in pre-existin hollows of the Waverly, and thus are limited on all sides by the edge of those local basins. Such circumscribed beds can not be said to be th equivalents of beds in other basins, until the connection is proven b exact physical profiles.

From the Muskingum to the Hocking the identity of seams No. 5 an 6, which form a pair, and lie only twenty-five or thirty feet apart, ma be considered as established, the Upper or No. 6 being the Great Seam o Perry county. Beyond this, towards the Ohio River, there is still a discussion between Professor Andrews and other eminent geologists, in regard to the equivalents of the Putnam Hill limestone, and of the No. coal. If it can be established that No. 6 is continuous from the Pennsylvania line to the Ohio River, the reports will be vindicated, and th Ohio system will assume much more simplicity. At present it can onl be said that one coal seam has been traced with certainty through th series, and that is the *Pittsburgh, Wheeling, and Pomeroy bed*, above the so-called barren measures.

Using this as the only well-fixed horizon, there are below it, as represented in the above table, in Columbiana and Jefferson counties ten (10) seams of coal and six (6) of limestone. In the Conotton Valley, according to Prof. Read, there are seven (7) beds of limestone, and seven (7) o coal. In Muskingum county eight (8) seams of coal, and twelve (12) o limestone. Further south, at Hocking and Athens counties, different observers do not agree as to the number of limestone, iron ore, and coal strata. There are profiles showing eleven (11) beds of limestone, and seven (7) seams of coal. In Gallia and Lawrence counties, on the Ohio River, Messrs. Andrews and Gilbert give in the same vertical space, seven (7) beds of limestone, and ten (10) of coal.

On the waters of the Tuscarawas, in the county of Stark, the west half of Carroll, Tuscarawas, Wayne, and Coshocton, is a geological field, where the strata have many features in common, which may be recognized as far south in Licking and Muskingum counties as the Licking River and the National Road. Beyond this line in that direction, changes occur in the number and the character of the beds, which renders it difficult to establish strict identity in the series.

In the other direction, on the waters of the Great and Little Beaver Rivers, and of Yellow Creek in the east half of Carroll, in Columbiana, Mahoning, and Trumbull counties, and over the line in Pennsylvania, there is also a manifest difference in the deposits, from those on the waters of the Tuscarawas. Notwithstanding these variations, Professor Newberry concludes, that coal seams Nos. 5 and 6 are continuous from the Pennsylvania line on the east, through the summits between the waters of the Beaver and the Tuscarawas Rivers, to Zoar, Trenton, Coshocton, Zanesville, New Lexington, and Straitsville.

Coal seam No. 1 has been traced from the valley of the Mahoning, on the east line of the State, along its outcrop through Portage, Summit, Stark, Wayne, and Holmes counties.

No. 1 coal beneath these very regular beds, is very irregular of deposition. It consists of a series of hollows and ridges, sometimes connected and at others isolated, the rims of which are thirty to fifty feet above the bottom. In the coal seams above the lower lime-rock group, the same irregularity may be seen. Coal seams Nos. 5 and 6, and the associated rocks on Yellow Creek, vary in level eighty and one hundred feet in a mile. At Morgan Run, near Coshocton, there are waves in the upper seams like those at Massillon and Niles in the lower ones.

No. 3, or the lower limestone coal seam, is readily traced from the Mahoning Valley westerly, lying about one hundred and sixty feet above No. 1, as far to the west and south-west as Sugar Creek Valley, in the north-western part of Tuscarawas county.

ELEVATIONS OF POINTS IN THE LIMESTONE GROUP.

Places of observation.	Elevations above Lake Erie.			Vertical space of the group.
	Lower limestone, No.1 .	Middle limestone, No. 2.	Upper limestone, No. 3.	
Poland	340(?)	365(?)	425(?)	85(?)
New Lisbon	290	Not given.	485	195
Navarre	452	477	565	113
Bolivar	386	422	450	64
Agnus Hill	370	476	557	187
Avondale	316	351	384	68
Zoar	300	370	Not seen.	Not seen.
Magnolia	336	376	416	80

From the Mahoning westerly to the heads of "Big Sandy," near Hanover Station, only a short space below No. 6 coal, is a bed of lime rock, designated as the "white limestone." This is not to be confounded with the white lime rock above the so-called No. 7 coal, on Yellow Creek.

The connecting link between the Tuscarawas Valley series and that of Little Beaver, is the lime rocks Nos. 1 and 2, over the so-called coals Nos. 3 and 4. Above these beds the strata are far from regular or persistent, requiring further and closer examination.

The profiles made by Prof. Stevenson, near Magnolia, in the north-west corner of Carroll county—by Prof. Newberry, at Mineral Point and Zoar Station, near the north-east corner of Tuscarawas county—by myself, from Bolivar to Massillon, in Stark county, and by Prof. Andrews, in Sugar Creek valley, near the forks at Deardorf's Mill, are so diverse, that they cannot as yet be made to fit each other. (See Figures 1 and 2.)

The great puzzle of our system is, to determine where those beds which are lost, terminate, and where those which are nearly on the same horizon, come in. Nothing but exact physical work can determine those points, and in many parts of the field such work is yet wanting. If the strata taper out on the line of their strike, they must also taper out on the direction of their dip, and therefore, in some instances, exist only as local patches. This feature of the Ohio series renders it one exceptionally difficult to survey.

I find in the reports frequent allusions to the completeness and value of this survey. Here, in the midst of the series, is an area of at least five townships, occupying a valley twenty miles in length, embracing all the beds of the lower coal strata, open to inspection in hundreds of places, with all the materials for making iron in abundance. The valuable information which the public may extract from all the reports relating to this region, might have been acquired by an active explorer in one day.

The officers of the C., C., C. & S. Railroad Co. found so little had been done in this region, that it was necessary for the company to make a detailed survey for itself. Prof. Andrews, in the prosecution of this work, with the assistance of Mr. H. D. Dennis, and of W. Jones, the engineer, was unable to connect these beds with those of the valley of the Kilbuck on the west, or of the Tuscarawas on the east. An undiscovered horizon of blackband ore was brought to light by him, and a bed of coal, not noticed by the Survey. For these reasons, it becomes necessary to give something more than a general notice of this important mineral region. The sandstones are not a reliable guide in determining the equivalency of strata; in truth, the more complete and exact our explorations become, the more numerous and more perplexing these irregularities appear.

Until the third limestone was discovered by Prof. Andrews, in the

Sugar Creek valley, it did not seem possible that No. 6 could be persistent. By extending the white limestone of Columbiana county—the first one below No. 6 coal—to the westward, through Tuscarawas, the position of the report is strengthened. On that basis the place of No. 4 coal and No. 2, or the " Putnam Hill limestone," must be changed in several of the sections.

The Zoar section, which is a typical one for this region, and to which the lower coal series of the State has been forced to conform, does not show this lime-rock. (See profile No. 2.) Until it was oberved in the Sugar Creek valley, I did not feel sure of its existence west of Hanover, in Columbiana county, although there are fragments of it in the drift of Suffield, in Portage county. It is only for convenience and provisionally that the terms *blue*, *gray*, and *white* are applied to the lower, middle, and upper limestones. All of them are, in places, blue; all of them have coal beneath, and, generally, a show of iron ore above.

Large quantities of shell and block ore have been mined, resting upon No. 2, or the "gray limestone" of the reports. This has also been confounded with the white or No. 3. Its existence there, though unfortunate for the typical section of the State, sustains the theory of the report in regard to the general persistence of No. 6 coal seam. The Putnam Hill limestone is, however, thrown out of place in several cases by the better establishment of this coal.

Where this is made typical among the limestone beds, by Prof. Andrews, it is the first regular bed below Coals Nos. 5 and 6, between which there are no lime strata in that part of the State.

Using the physical sections of Mr. Jones, I connect this bed with the upper one at Rowville, 480′ A., and 71 feet below No. 6 coal, rising to the northward as far as Fisher's coal mine, where it is 538″ A. The lower limestone coal at Avondale thus becomes No. 1 of the Ohio series, over No. 3 coal, and the middle one No. 3*a*. Above this, No. 3*b* coal is wanting here. The bed of flint on this profile next below No. 5 coal is probably local. In the valley of White Eyes Creek, according to Prof. Andrews, the Avondale profile holds good, with little variation.

No. 4, of the report of 1870, is now regarded as No. 3*a*. No. 4 proper, is the second, or "*gray limestone*" seam, a companion of No. 1, in both of which there is a lime-rock roof. From the valley of the Mahoning to that of the Tuscarawas, near Massillon, they are only twenty-five to thirty feet apart, very regular and conformable. The lime beds being the result of an action not merely sedimentary, but, like the iron ores, also of chemical segregation, in quiet waters will form in more perfect planes than the shale, sand-rock, and coal strata.

On the west side of the south fork of Sugar Creek is the usual bed of sand-rock over Coal No. 6. On the east side of the same valley it is principally wanting, replaced by shale, in which are important beds of iron ore. Such irregularities in our deposits perplex the explorer, but should not surprise him, for this is one of the most uniform characters of the Ohio series. This fact should make him very cautious in deciding upon equivalents.

The Deardorff sandstone overlying No. 3 coal, and its lime-rock, is easily traced from Justus Station to Beach City and Agnus Hill, and thence on both sides of the valley to school-house No. 7. Neither the Deardorff sandstone, the limerock just above it, nor the coal bed a few feet higher, fall into proper relations with the beds named in the survey.

The lime-rock, 38 feet above the Fisher coal, 538 feet above Lake Erie, is at the Shetlar mine, near Navarre, 542 feet, and 36 feet below Coal No. 5. Here No. 6 is 42 feet higher, overlaid by sandstone to the top of the hill, 30 to 40 feet thick. At Agnus Hill No. 5 is worked at an elevation of 575 feet. At Shetlar's it is heavier than No. 6.

The Fisher bank, Weimar's, lower Agnus, Schrock's, and Nead's banks, with those in the same horizon, for convenience of description I have called No. 3*b*. This coal is very regular in thickness, 3 to 3½ feet, easily wrought, lies above drainage, and is of mercantile value. As a part of the geological series, it must be regarded as local, covering a comparatively small field. South of the summit it has not yet been found. It is highly probable, however, that the lime-rock No. 2 in the Avondale profile of Prof. Andrews is the same that crops out on Sugar Creek, 10 to 20 feet below this coal. Here there is a coal bed underlying it, which I have called No 3*a*.

On the west side of the valley No. 6 is well defined, from Wilmot to Shoup and Baker's mine, overlaid everywhere by a heavy sand-rock, 40 to 60 feet in thickness, forming the surface of a high ridge, 640 to 660 feet above Lake Erie. It is 3½ to 5 feet thick, and has a very strong heating power. Following it southerly to Shanesville, Harman's, and Farmersville, it becomes more dry burning, and is a very bright black and handsome coal. No. 5 in this direction becomes less regular but is workable in several places.

In profile No. 4 I have represented the general structure of this region. Beds within two miles of the general course of the profile are projected on a vertical plane, which is placed near the line of the Tuscarawas Valley and the Beach City and the Coshocton Railways. It represents three beds of coal, and in places four, having a workable thickness. In no place is there less than one, and in many places *three* beds of limestone above drainage. The iron ores are not represented. Along the highlands between Sugar Creek and the Tuscarawas, ore has been uncovered at numerous points from Navarre to Strasburg, principally over No. 2 limestone and No. 5 coal. These ore seams appear on both sides of the south fork of Sugar Creek, as far as Rowville, and some of the hills are high enough for those over No. 7 coal.

The above table of elevations in the limestone group shows that the railway route from Canton, by Beach City to Rowville, is nearly on the line of bearing of the strata where they are approximately level. Limestone No. 3, at Navarre, is 566, a mile east of Beach City 536, Agnus Hill, 551, Shanesville, 486, Rowville, 480. I have calculated the local dip of all the beds in the vicinity of this line, and find it to be south-easterly, but very slight, 12 to 15 feet per mile. The lower limestone, or No. 1, on a line due south from Greentown to Zoar, a distance of 25 miles, sinks from 455 to 300 feet, or 155 feet. From Rowville south the beds dip more rapidly. No. 6 coal, which is here 551, is at Avondale 447, a difference of 104 feet in five miles.

At Coshocton it is not well settled which of the beds is No. 6. At Trenton, 15 miles south, 70° east from Rowville, it is 336 feet, making a descent of 215 feet, equal to 14½ feet per mile. Over small spaces, when the local undulations are considered, the beds for mining purposes may be regarded as level, the best points for making entries to be determined by survey of each location. Here the number of seams of coal in the lower series is *nine*, but of these only *four* are of merchantable value.

CLEVELAND, OHIO, *November* 1, 1878.

COLUMBIANA COUNTY, OHIO.

ITS GEOLOGICAL STRUCTURE.

BY COL. CHAS. WHITTLESEY.

In my contributions published in 1869 before there had been any reports from the Second Ohio Survey, after constructing a number of triangles for dip in Mahoning and Trumbull counties in coal seam No. 1, I came to the conclusion that if it is persistent to the Ohio River, its depth at the mouth of Little Beaver below low water, should be about 280 feet. In the Ohio Report of 1870 Prof. Newberry asserts that this bed lies beneath the valley of the Little Beaver from New Lisbon to the Ohio, a distance of about 18 miles, within easy reach for mining. It is ordinarily about 160 feet below our limestone, No. 1, over No. 3 coal, and according to the Ohio reports this lime stone and its coal is at the mouth of Little Beaver, near the Ohio line, 126 feet above low water, and therefore coal No. 1 should be found at (34) thirty-four feet below the river bed. Mr. White, in the Pennsylvania Report Q. Q., and Professor Lesley, state with the utmost confidence, after great detailed examination, and after making about forty local sections, that Professor Newberry's No. 1 lime stone is the "*ferruginous*" of the Pennsylvania Reports, which is the same as the white limestone at Lowell, Mahoning county, Ohio, and is within fifty feet below coal No. 6 of the Ohio Reports. In all his sections and reports, Professor Newberry correlates our white lime stone, or No. 3 of our series, with the "Upper Freeport lime stone" of Pennsylvania, which is nearly 250 feet above the Lowell lime stone. If Professor Lesley and his assistants are right, here is a discrepancy between the reports on two sides of the same line of over 200 feet, involving the existence or non-existence of three beds of coal. Professor Newberry failed to discover and to report upon the White or Lowell limestone, in the Valley of the Tuscarawas. His typical Zoar Section has it not. In that, limestone No. 2 over coal No. 4 is made the equivalent of the Putnam Hill at Zanesville, the most leading characteristic of which is, that it is the first lime stratum beneath coal No. 6. Probably the White limestone exists at Zoar, at its proper place, but eluded the search of the chief geologist. At Navarre, eight miles north of Zoar, I have a section taken by Mr. Jones with an engineer's level, in which all three of these limestones crop out in the public road, in the same hill.

Coal No. 1 in the Warmington and Clarke shafts, about two miles north of Navarre, ranges from 280 to 300 feet above Lake Erie, the canal being 354 feet.

Limestone No. 1 or the Zoar (blue) is 452 feet A. L. E., or about 160 feet above coal No. 1 as usual. Limestone No. 2, the gray of our reports overlying coal No. 4 is 478 feet A. L. E. or 26 feet above the blue.

The white limestone is 565 feet A. or 87 feet above the gray, and 113 feet above the blue. Coal No. 6 lies at an elevation of 607 feet or 42 feet above the white limestone. I have constructed a profile from Navarre through Arter's mine, four miles north of New Lisbon in Columbiana county to Lowell on the Mahoning river near the State line, in order to connect the strata of the Tuscarawas Valley with those of the Pennsylvania reports. In the Valley of the Little Beaver I did not see the white limestone next below No. 6, but in place of it is a blue limestone at the proper level, and which is doubtless geologically the same. Color is of little value in identifying the limestone beds. They assume all colors at short distances. I think it would be better to drop the terms blue, gray and white, and call this group the Zoar, Navarre and Lowell limestones.

In Pennsylvania the two lower are known as the lower and upper "Mercer Limestones." The white or upper one of our groups is there called the "ferruginous limestone," which is the name of quite another stratum in Ohio. The terms "ferruginous," "crinoidal" and "fossiliferous," applied to any of these beds are unfortunate, and lead to confusion.

The section of Professor Lesley and Mr. White at Lowell, which is about N. 70 degrees east 55 miles from Navarre, is almost identical, with mine at the former place. Coal No. 1 at Mt. Nebo, less than two miles north of Lowell, lies 225 feet A. L. E., and the Zoar lime stone at about 400, making the interval about 175 feet. The Navarre lime stone is about 30 feet above the Zoar.

The white or "ferruginous" of Pennsylvania, or the Lowell lime stone, is 113 feet higher, or the same as at Navarre, and coal No. 6 is about 50 feet higher.

As an intermediate section connecting these, I use that of Professor Newberry in the Valley of Little Beaver near New Lisbon Coal No. 6 at Arter's mine is 530 feet A. L. E. This point is nearly east of Navarre about 32 miles, and being to the right of the line of bearing, the beds are somewhat lower. At Arter's I did not see the White or Lowell lime stone, but Professor Newberry reports it to be about 25 feet below No. 6 coal. The Zoar limestone and coal No. 3 lie a short distance down the valley at 394 A. L. E., making the interval between the Lowell and the Zoar about 116 feet. The interval between No. 3 and No. 6 coal is here less than usual, or 136 feet. Usually the space between coals No. 1 and No. 6 is about 300 feet.

Mr. White traced the Lowell limestone by closely connected sections down the Mahoning, the Big Beaver and the Ohio, to a point nearly opposite Industry, where it is in full thickness, with the usual fossils at the level of the river and about 100 feet above Lake Erie. Its dip on this line is about 400 feet, which is south about 7½ degrees east, distance 30 miles from Lowell; or at the rate of about 13 1-3 feet per mile. My best calculations for dip in the Valley of the Mahoning gave for No. 1 coal, South 22 degrees, East 14 feet per mile. Assuming that Mr. White is correct in fixing the Lowell lime stone at the mouth of Little Beaver, a few miles below Industry, at 133 feet above the lake, which differs only 7 feet from Professor Newberry's, place of No. 3 coal and its lime stone cover, I now construct a triangle for dip, by passing a plane through this lime stone at Lowell, at the mouth of Little Beaver, and at Arter's, four miles North of New Lisbon. The sides are 20 to 28 miles each and the result is for dip, South 50 degrees, East 15¼ feet per mile. If the Pennsylvania geologists are right and they have done good local work and speak with absolute confidence; the position of coal No. 1 on the Ohio should be 280 to 300 feet below their Lowell lime stone, or 240 to 260 feet below the Ohio.

Turning in the other direction and looking through Southern Columbiana county, I am not able, as yet, to identify there the Freeport coals and limestone, which are nearly 250 feet higher than the Lowell limestone. The next limerock in our series is more than 300 feet higher, which carries it into the so-called barren measures.

This is the "crinoidal" of the Ohio Reports. Between Little Beaver and Yellow Creek there is a manifest change in the stratification, not the result of upheavals or undulations, but of irregular deposition. I hope the Pennsylvania geologists will invade Ohio still farther, and continue their local sections down the Ohio and up Yellow Creek. At present everything is in confusion there. From Canton, in Stark county, Ohio, we have reliable physical profiles, through Navarre and the Sugar Creek Valley, over the Rowville Summit to Coshocton. Near Rowville the upper or white limestone is well exposed, but at a little greater distance below No. 6 coal than the white in Columbiana, and it may be local. The color is changeable, and is due to variable proportions of protoxide and proto-carbonate of iron. The first lime rock below coal No. 6 at Coshocton is black, which, however, I am told calcines to white. Its dark color is probably due to bitumen. This indicates a connection with the Putnam Hill limestone at Zanesville, but this is still to be demonstrated. In case the Lowell limestone can be shown to be continuous from Navarre to Coshocton and thence to Zanesville, the Ohio geology becomes much simplified, and the continuity of No. 6 coal will be established from the Pennsylvania line to the Hocking Valley.

Looking over the entire line of outcrop from Rowville in the west part of Tuscarawas county northerly and easterly through Stark, Columbiana and Mahoning counties, there must be breaks in the Lowell limestone or in coal No. 5. According to the State Geologist, the White or Lowell limestone at Achor on the State line, at Elkton, in the Valley of Little Beaver, at New Lisbon and Arter's mine, lies *above* No. 5 coal. According to Professors Reid and Stevenson, it is the same in the valleys of Big Sandy and Connotton.

On the Tuscarawas Professor Newberry did not find the Lowell limestone. At Navarre, Shetlars, Agnus Hill, Dundee, Shanesville and Rowville, a distance to the southwest of thirty miles, the first limestone below No. 6 coal is also *below* No. 5

All the field work and the reports relating to Columbiana, Stark and Tuscarawas counties, covering a period of ten years, was executed by the State Geologist in person.

I have shown heretofore that what pertains to Tuscarawas county is so erroneous and defective that it requires immediate revision. I have repeatedly made the same criticisms upon the official survey of Columbiana county. In both counties strata are omitted, and others misplaced. It is to the people of the Valley of Little Beaver and others who are interested in its mines no small matter whether coal No. 1 is eighty or two hundred and fifty feet below drainage. If the Pennsylvania geologists are right they have done an acceptable service to Ohio in correcting what I conceive to be gross faults in the Ohio survey. If they are right, instead of coal No. 3 and its limestone with coal No. 4 and its limestone, lying high in the hills at the mouth of Little Beaver, they are both beneath the bed of the Ohio River.

Cleveland, February 1, 1880.

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